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Canada. Mines, Bureau of.

SUMMARY REPORT

OF THE

MINES BRANCH

OF THE

DEPARTMENT OF MINES

FOR THE CALENDAR YEAR ENDING DECEMBER 31

1917

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To His Excellency The Duke of Devonshire, K.G., P.C., G.C.M.G., G.C.V.O., etc., etc., Governor General and Commander in Chief of the Dominion of Canada.

MAY IT PLEASE YOUR EXCELLENCY,—

The undersigned has the honour to lay before Your Excellency, in compliance with 6-7 Edward VII, chapter 29, section 18, Summary Report of the work of the Mines Branch of the Department of Mines during the calendar year ending December 31, 1917.

MARTIN BURRELL,
Minister of Mines.

HON. MARTIN BURRELL,
Minister of Mines,
Ottawa.

SIR,—I have the honour to submit herewith the Director's Summary Report of the work of the Mines Branch of the Department of Mines during the calendar year ending December 31, 1917.

I am, sir, your obedient servant,

R. G. McCONNELL,
Deputy Minister

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SUMMARY REPORT

OF THE

MINES BRANCH OF THE DEPARTMENT OF MINES FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1917.

INTRODUCTORY.

The increased development in the mining industry of the Dominion during the year 1917—attributed, for the most part, to the European war—added materially to the special work and activities of the various divisions of the Mines Branch. The unusual trade demand for minerals, both metallic and non-metallic, caused considerable stir among mining companies, prospectors, and others, more or less interested in the general mining industry of the country. This resulted in numerous inquiries at the Mines Branch as to possibilities in fields already investigated; and in many applications for expert technical advice with regard to the character and commercial value of minerals discovered; or with reference to the problems and difficult conditions encountered in manufacturing processes, or in connexion with promising mineral and fuel lands opened out.

The general operations of the Mines Branch consisted in the field investigation of certain metallic and non-metallic mineral occurrences, including iron ore deposits, and particular limestone, sand, and clay areas; while the essentially practical work of the branch consisted in the testing of ores, metals, fuels, oils, and gases, and the examination and determination of mineral specimens, all conducted in the various physical and chemical laboratories and testing plants at Ottawa. In addition to this technical work, statistics relative to mineral production in Canada were collected, and duly published.

The concentration of molybdenite ores—undertaken in 1917, for the Imperial Munitions Board—was continued; as also was the analysis of ferro-silicon shipments made on behalf of the War Purchasing Commission.

In view of the active movement in the western provinces for better highways, Mr. G. C. Parker, of the Department of Public Highways, Toronto, was commissioned by the Mines Branch to make an investigation of the bituminous sands of Alberta, in order to ascertain their adaptability for surfacing country roads. A report embodying the result of this investigation will, it is expected, be ready for publication early next season.

During the year the usual statistical reports, together with several technical reports of special importance, were issued; reference to which, and to the specific work undertaken by the different officers of the staff, will be found in subsequent sections of this annual summary report.

ORE DRESSING AND METALLURGICAL DIVISION.

The work of this Division during the year was, for the most part, confined to investigation of minerals needed for war purposes. The concentration of molybdenite ores on a commercial scale, begun the previous season, was continued; so great being the demand by munition authorities for molybdenum that the Ore Dressing Laboratory was operated to its full capacity, and a great part of the time three shifts were being worked.

Furthermore, the laboratory undertook for the Imperial Munitions Board the sampling and assaying of ferro-molybdenum. In addition, other classes of ores were

received and tested, the results of which are given in the reports submitted herein by officers of the Division.

FUELS AND FUEL TESTING.

The work carried out during the season of 1917 by the Division of Fuels and Fuel Testing consisted, in part, of the continuation of large scale tests in connexion with coals from the Province of Alberta. Examination was made of several peat bogs; and the chemical laboratories were fully occupied with analyses of oils, gases, coals, peat, and mine air.

The investigation begun the previous year relative to the carbonization and briquetting of our Western lignites was continued; and arrangements were made for the examination of distillate oils, with a view to determining their use in internal combustion engines.

CHEMICAL LABORATORIES.

The several chemical laboratories of the Mines Branch have, during the year, been engaged to their full capacity. The work undertaken has, as usual, been of a diverse character. In addition to the analyses of current samples of metalliferous ores and non-metalliferous minerals received from several officials of the Department, and from outside sources, particular attention has been given to the examination of war materials. In this connexion, mention might be made of the analysis of ferro-silicon for the War Purchasing Commission; the testing of oils for the Militia Department; fuels for the Public Works Department, and the Fuel Controller; together with chemical work necessary in connexion with investigation undertaken by our Ore Dressing and Metallurgical Division for the Imperial Munitions Board and the Canadian Munitions Resources Commission.

Reference to the specific work accomplished in the various laboratories of the Mines Branch is to be found in succeeding parts of this report.

IRON ORE DEPOSITS.

During the field season of 1917, Mr. A. H. A. Robinson—in charge of a party, made an examination of a number of reported iron ore occurrences in the Rainy River district, Ontario.

Further reference to the work accomplished is to be found on page 11.

INVESTIGATION OF LIMESTONES.

During the field season, the investigation in connexion with limestones—in 1916—was resumed by Mr. Howells Fréchette. Activities were confined to the Province of Ontario, where important limestone areas were examined and samples taken. These were subsequently analysed in the laboratories of the Mines Branch.

On page 23 will be found a preliminary report of the work accomplished by the officer in charge.

INVESTIGATION OF THE GRAPHITE INDUSTRY.

Owing to curtailment of the foreign supply of graphite, there is a great demand for the Canadian product, the bulk of which finds a market in the United States.

Notwithstanding this condition, Canadian production has not been able to meet the demand. In view of this fact, Mr. H. S. Spence was commissioned to make an investigation as to the causes of laxity in the trade, and to suggest ways and means which would lead to an increased activity in the graphite industry.

INVESTIGATION OF THE SANDS AND SANDSTONES OF CANADA.

The field work in connexion with this investigation during the season of 1917, consisted, in part, of the examination of certain deposits in eastern Canada, the product of which was reported to be suited for use as pulpstones. Samples were obtained and tests made thereon, the results of which were so encouraging that it may be said that a Canadian stone may be had that compares favourably with that imported; a bulletin dealing especially with this investigation was published and may be had on application. Examination was also made of sand and sandstone deposits in Ontario, and certain special areas in Quebec, and the samples taken are now being tested in the Mines Branch Laboratories. This work is to be continued during the coming field season, when it is expected that enough data will be available to enable complete reports on silica and on the foundry moulding sands of Canada to be issued.

METALLIFEROUS MINES DIVISION.

The developments arising out of the great war have made it necessary for the department to widen the scope of its work of securing information with respect to Canada's mineral resources and their utilization. The great importance of chemical manufacturing has been made patent to every one during the last two years, and many inquiries received in the department made it desirable to secure specific information as to the development of chemical manufacturing in Canada. Dr. A. W. G. Wilson was instructed to make a preliminary investigation of this field in the summer of 1916; and the work was begun late in the fall of that year, and continued during the first seven months of 1917. In the course of the investigation, all the principal cities and the more important towns in all the provinces of Canada were visited, with a view to ascertaining the number and variety of the chemical manufacturing industries established throughout the country. Inquiries were instituted to ascertain the source of the raw materials required, and the markets in which the finished products were distributed under normal conditions. The information obtained has already been of value in enabling the department to furnish information in response to a number of inquiries for specific materials or products.

A report on the chemical industries of Canada and their relation to the mineral industry, is in course of preparation. In this report, particular attention will be given to the subject of markets for Canadian mineral and chemical products, and to the possibility of substituting home products, of mineral origin, for foreign materials now imported.

Dr. Wilson was in attendance at the chemical exhibition in New York during the week of September 24, for the purpose of studying the exhibits, and for acquiring information that might be of advantage to the department, or helpful in the preparation of the above-mentioned report.

In October, Dr. Wilson was sent to St. Louis to attend a conference of the War Minerals Committee of the United States. The situation with respect to the sulphur supply, and the possibility of producing additional quantities of pyrites for the United States market, were the topics of discussion of most importance to Canada.

DIVISION OF MINERAL RESOURCES AND STATISTICS.

In the work of this division, a feature of special interest during the past two years has been the inauguration of a more frequent collection of production statistics than the annual record. Monthly records of production of coal, coke, pig-iron, steel ingots, asbestos, and pyrites ore have been collected during 1917; and these records have proved to be of the utmost value at the present time, furnishing, as they do, a continuous and up-to-date record of the progress of these industries, and of the quantities of materials available.

During the year under review, there were completed for publication, six separate reports on mineral production; and seven separate lists of mine and quarry operators; besides a number of special bulletins and press notices, dealing with the interim statistics of production, referred to above.

Arrangements have been made with the Census Office of the Department of Trade and Commerce whereby that office shall accept as census records the statistics of mineral production collected by the Department of Mines; and for this purpose, the Chief of the Division of Mineral Resources and Statistics has been appointed, by Order in Council, as a special agent of the census. Unnecessary departmental duplication of inquiry will thus be avoided.

The preliminary report on mineral production shows the rapid growth and development of the mineral industry in Canada, and the extent to which Canada has been able to contribute of her mineral resources both to the prosecution of the war and to the country's industrial progress.

CERAMIC DIVISION.

The work of this division consists in the investigation and examination of the clay and the shale resources of the Dominion. During the year, numerous samples, collected in the field, or submitted by outside parties, were tested and reported upon. Several field trips were undertaken to examine the clay deposits of eastern Ontario; and special attention was given to the location of high-grade clays, owing to the great demand for these requisites in the paper industry, at the present time, and for metallurgical purposes. In another part of this report, Mr. J. Keele, Chief Engineer of the Division, presents the result of the season's work.

ROAD MATERIALS DIVISION.

In the Summary Report for 1916, reasons were given for the establishment of a road materials division. The work of examining suitable road materials along important existing and proposed new highways, was undertaken by several field parties: samples being procured, and forwarded to the Mines Branch laboratory, to be tested. In addition to this work, samples from several Provincial Highway organizations were received and reported upon. A full account of the investigations, and the results of tests made, are given in another section of this report.

TECHNICAL LIBRARY.

The Technical Library of the Mines Branch has grown to such an extent during 1917, that the shelving capacity has been enlarged by 25 per cent.

Additions were made to the Library by gifts from Geological Surveys and cognate departments—683 Government documents; from Scientific and Technical Societies—260 Bulletins, Proceedings, and Transactions; and by private gifts, 34 volumes.

Additions by purchase, 113 volumes; and 91 volumes have been bound.

The services of the Library have been placed at the disposal of the various Munitions Boards; and for the especial benefit of these Boards, a number of new exchanges, which are entirely dedicated to war work, have been inaugurated with Technical Societies.

EUGENE HAANEL,
Director.

INDIVIDUAL SUMMARY REPORTS.

METALLIFEROUS MINES DIVISION.

I

INVESTIGATION OF IRON ORES.

A. H. A. Robinson.

The field season of 1917 was devoted to the investigation of a number of reported occurrences of iron ore in that part of the Rainy River district lying just east of Rainy lake, Ontario. Magnetometric and topographical surveys were made covering a length of about 2½ miles along a zone of titaniferous iron-bearing rocks that occur to the north of Seine bay, Rainy lake, and to the northwest of Bad Vermilion lake. This ore-bearing belt has a total length of about 14 miles. The portion of it chosen for mapping this season, is that which crosses mining locations AL25, AL26, AL27, AL28, and AL29, near the middle of the range and lying between the east end of Seine bay and the southwest corner of Bad Vermilion lake. This section is, for the most part, heavily drift covered, and shows few outcrops. A magnetometric survey of it, therefore, adds more to our information concerning the range, as a whole, than would one where natural outcrops and exposures give, at least, a general idea of the extent and distribution of the ore-bodies. With the time and means at our disposal, a magnetic survey of the whole 14 miles would have been impossible this season.

In addition to the magnetic survey of the titaniferous magnetite deposits between Seine bay and Bad Vermilion lake—which occupied most of the summer—visits were made to a number of places along the line of the Canadian Northern railway between La Seine station and Fort Frances, at which, at various times, iron ore has been reported to occur; but no deposits that showed promise of being of economic value as sources of iron ore were seen at any of them. There is, however, a belt of rusty iron-stained rock, presumably belonging to the Keewatin iron formation, that can be traced more or less continuously along close to the railway from near Nickel Lake siding to Rocky Inlet, and beyond. Associated with this belt of rusty gossan-bearing rocks are deposits of iron pyrites and pyrrhotite, some of which might, if explored, prove valuable for their sulphur contents. A little prospecting has been done on a showing of iron pyrites on the south shore of Nickel lake, and, also, on deposits of pyrite and pyrrhotite that occur on the west side of Rocky Inlet, a little to the north of the railway. Not enough work has been done on any of them, however, to show whether or not they are extensive enough to be workable.

Grateful acknowledgment is due to Dr. W. L. Goodwin, of Queen's University, Kingston, for much valuable information and assistance rendered in connexion with the work on the Seine Bay titaniferous iron range. Mr. Gordon G. Vincent, and Mr. Gilbert C. Monture, acted as assistants throughout the season, and performed their duties in a highly satisfactory manner.

THE TITANIFEROUS MAGNETITE DEPOSITS OF SEINE BAY AND BAD VERMILION LAKE.

Location and Topography.

What may for convenience be called the Seine Bay iron range, is a belt of basic igneous rocks associated with which are numerous deposits of titaniferous magnetite. It has a total length of about 14 miles. Starting on the south shore of the peninsula

between the two arms of Rainy lake, known respectively, as Swell and Seine bays, at a point half a mile east of Wind bay, it extends northeasterly in a gently curving line along the north side of Seine bay, and the northwesterly shore of Bad Vermilion lake to a point about two-thirds the way up the latter. It crosses, in its course from west to east, the following mining locations: 213X, 170P, 171P, 181P, 182P, 183P, 215X, 216X, 217X, 218X, AL33, AL32, AL31, AL30, AL29, AL28, AL27, AL26, AL25, AL24, AL23, AL16, AL17, AL18, AL19, AL20, AL21, AL22, and HP96. (See sketch map.)

Emerging from the water of the bay on 213X, the outcrops of the iron range, on passing inland, rise to an elevation of between 100 and 200 feet above Seine bay, i.e., to between 1,200 and 1,300 feet above sea-level, and continuing for the most part at about this general elevation, follow along on the southerly slope of the rocky hills that bound the valley of Seine bay and Bad Vermilion lake on the north and northwest. With the exception of 2 miles between the east end of Seine bay and the southwest corner of Bad Vermilion lake, the range runs at no place very far from the shores of either one or the other of these two bodies of water. North of Seine bay its distance from the shore is probably never greater than half a mile; along Bad Vermilion lake it follows the shore more closely, coming down, at some points, almost to the water's edge.

Means of Access.

The easterly half of the range may be most conveniently reached from Mine Centre, a station on the Canadian Northern railway between Port Arthur and Winnipeg. A good wagon road about a mile in length leads from Mine Centre to Bad Vermilion lake where canoe or launch can be taken to within a short distance of the outcrops along the shore, or to the southwest corner of the lake whence a trail leading to Seine bay follows just south of the range nearly all the way.

The western part of the iron range is most readily accessible by way of Seine bay, from the north shore of which old lumbering roads can be followed inland to the outcrops at several points. Seine bay itself can be reached either from Mine Centre by the canoe route through Bad Vermilion lake, or by a longer but less laborious route from Fort Frances across the southern end of Rainy lake by gasoline launch. The distance from Fort Frances to the extreme western outcrops of the iron range on 213X is about 20 miles. Other short and easy routes to this end of the range would be by canoe or launch from Bear's Pass or Rocky Inlet stations on the Canadian Northern railway.

Geological Features.

The magnetite deposits are found in a belt of greenstones, gabbro, and various green schists, that lies sandwiched in between a belt of granite on the north and one of anorthosite on the south. The rocks most intimately associated with the ore-bodies are a very dark, rather coarsely granular, hornblende gabbro—partly massive and partly schistose—and green schist possibly derived from the gabbro by shearing and metamorphism.

The greenstones, schists, gabbro, and anorthosite—the last two probably differentiation products of a common magma—have all been classified as Keewatin. The gabbro and anorthosite, though they have been included with the Keewatin, are of later age than the other rocks mentioned above as belonging to that geological period, and were injected into the series in the form of sills or laccolithic lenses before its chief deformation and metamorphism took place. They thus partake of the structural features of the Keewatin. So far as is known they are confined to the Keewatin areas. The granite is intrusive into all the above-mentioned Keewatin rocks, and has been classified with the Laurentian.[1]

[1] "The Archæan Geology of Rainy Lake Re-Studied," by Andrew C. Lawson, Geol. Surv., Can., No. 24, Geological Series.

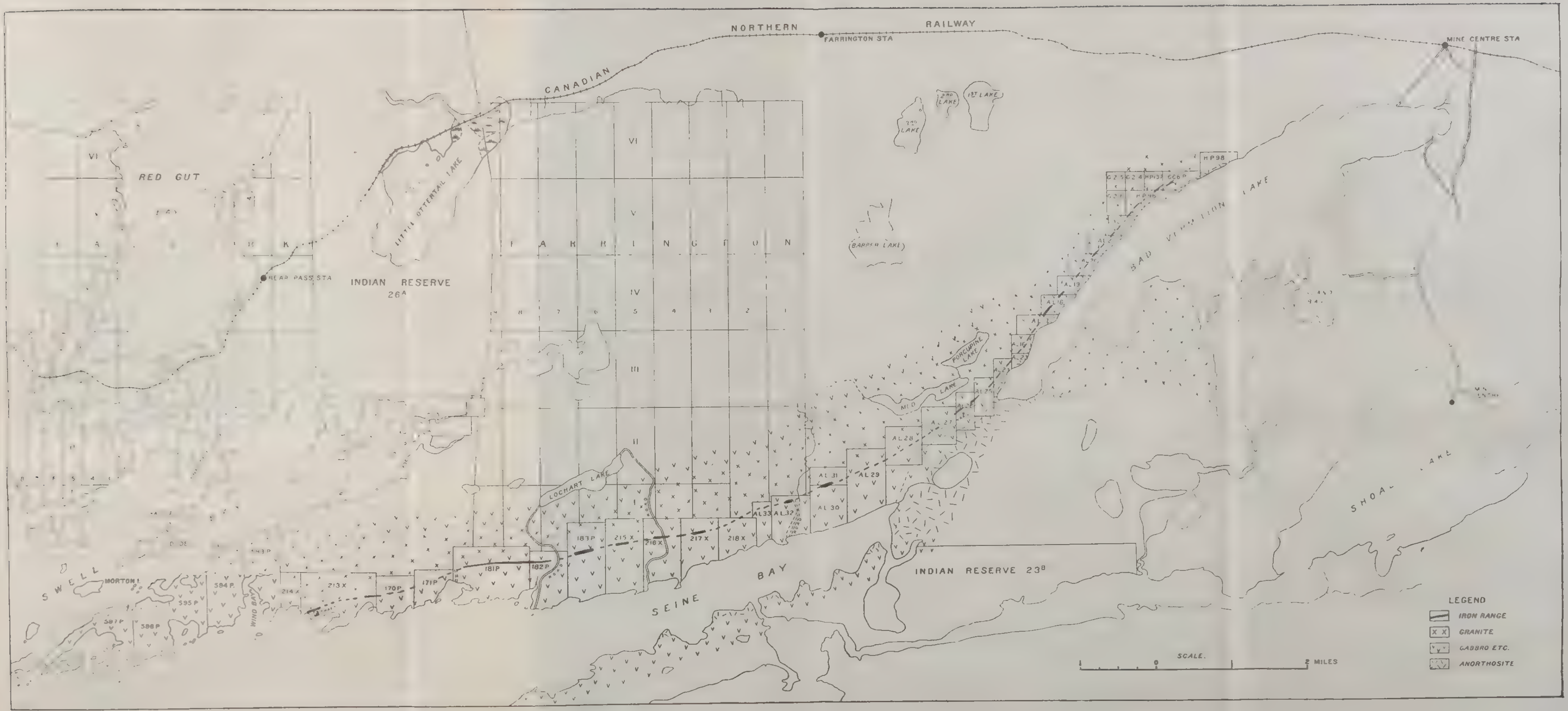

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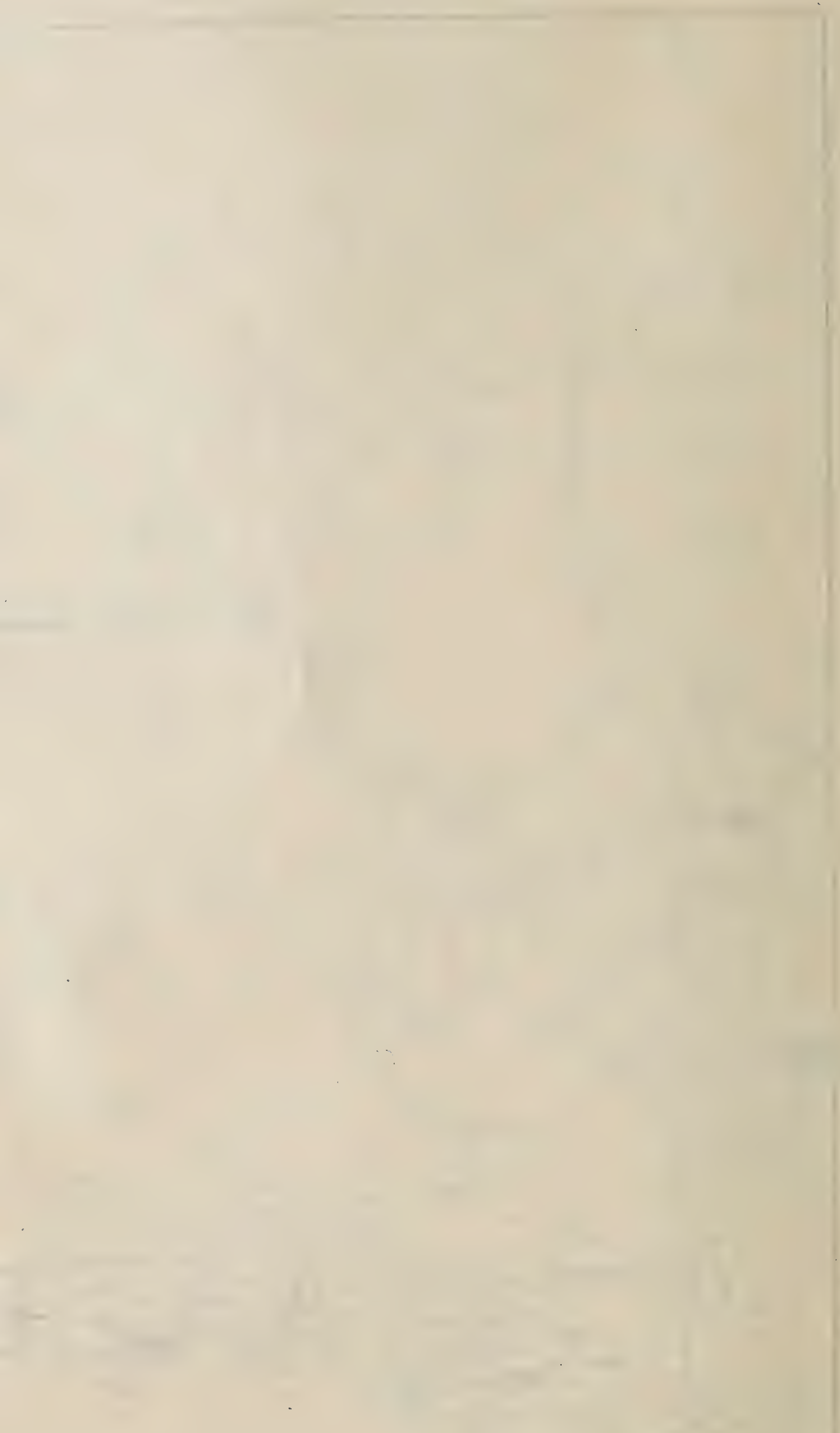
Fig. 1.—Sketch map, Seine Bay titaniferous iron range, Rainy River district, Ont.



The belt of granite already noted as lying to the north of the iron-bearing belt, extends much farther towards the northeast than it is shown on Lawson's map, and is to be found within a short distance of the iron range throughout the whole 14 miles the latter has been traced (see accompanying sketch map). A few small granite dikes, probably apophyses of the main body to the north occur in places penetrating the iron-bearing rocks—usually along planes parallel to their schistosity.

The ore-bodies, like most titaniferous magnetites, are believed to be of igneous origin, and to have been derived from the same magma as the anorthosite and gabbro by a process of segregation. They occur as flattened lenses standing on edge with their longer axes in a vertical plane parallel to the planes of schistosity in the surrounding rocks. Their present shape is probably due to squeezing, during shearing and metamorphism subsequent to their deposition.

Development.

Though these magnetite deposits have been known for some considerable time, and mining locations were first taken upon them a number of years ago, they have, on account of their high titanium content, not attracted as much attention as would otherwise probably have been the case, and comparatively little exploratory work has been done on them. Some trenching and diamond drilling was done north of Seine bay, on locations 181P, 182P, and 183P, by a Mr. Hunter, of Duluth, in 1911, and in 1917 six diamond drill holes were put down under the supervision of Dr. W. L. Goodwin, of Queen's University, on mining locations AL19, AL17, AL24, AL26, AL28, and AL29, respectively, at the Bad Vermilion end of the range. There is also an old prospecting shaft, or pit, now full of water where the range outcrops on the shore of Seine bay, on location 213X. The trenches, dug in 1911, have now, for the most part, fallen in, and at the present time, outside the natural exposures that are fairly numerous on some parts of it, little of interest is to be seen on the range.

The records of the drill holes put down in 1917 by Dr. Goodwin have been kindly supplied by him for publication, and will be found tabulated below. The Analysis number refers to the Table of Analyses given farther on.

Diamond Drill Hole No. 3.

Location.—On the south half of mining claim AL19.

Direction.—Northwesterly, at right angles to the ore-body.

Angle of hole.—53°

Elevation of collar of hole.—Approximately 1,160 (sea-level datum).

Elevation of bottom of hole.—Approximately 1,065 (sea-level datum).

Vertical depth of hole.—95 feet.

Depth.	Material drilled through.	Horizontal Width of Ore.	Analysis No.
Feet.		Feet.	
0·0– 18·0	Gabbro		
18·0– 18·5	Green schist		
18·5– 21·5	Magnetite	1·8	
21·5– 22·7	Green schist		
22·7– 29·0	Magnetite		
29·0– 86·0	Green schist with disseminated magnetite		
86·0– 88·0	Magnetite	1·2	
88·0– 96·0	Green schist with a little magnetite		
96·0– 99·0	Magnetite—6″ of calcite	1·8	
99·0–101·5	Low grade magnetite		
101·5–103·0	Quartz and schist		
103·0–110·0	Low grade magnetite	4·2	
110·0–119·0	Green schist		
End.			

Diamond Drill Hole No. 2.

Location.—At the water's edge, near the south boundary, on AL17; three-quarters of a mile S.W. of Hole No. 3.

Direction of hole.—Northwesterly at right angles to ore-body.

Angle of hole.—45°

Elevation of collar of hole.—Approximately 1,123 (sea-level datum).

Elevation of bottom of hole.—Approximately 869 (sea-level datum).

Vertical depth of hole.—254 feet.

Depth.	Material drilled through.	Horizontal Width of Ore.	Analysis No.
Feet.		Feet.	
1·0– 4·5	Casing		
4·5– 11·5	Magnetite	5·0	
11·5– 12·0	Schist		
12·0– 23·0	Magnetite	8·0	
23·0– 45·5	Greenstone with some magnetite		
45·5– 48·0	Magnetite	1·8	
48·0– 56·0	Greenstone with a little magnetite and calcite		
56·0– 66·0	Grey schist		
66·0–120·0	Green schist with some magnetite, pyrite and stringers of calcite.		
120·0–126·0	Green schist with a little magnetite		
126·0–137·0	Magnetite	8·0	*14
137·0–163·0	Green schist—Stringers of calcite and quartz		
163·0–165·5	Magnetite	2·5	
166·5–167·0	Green schist		
167·0–172·0	Magnetite	3·5	
172·0–178·0	Green schist		
178·0–186·0	Magnetite		
186·0–191·0	Low grade magnetite	5·6	
191·0–207·0	Green schist		
207·0–359·0	Gabbro with disseminated magnetite		*15
End.			

Diamond Drill Hole No. 4.

Location.—At foot of cliff, near the centre of AL24; three-quarters of a mile S.W. of Hole No. 2.

Direction of hole.—Northwesterly, at right angles to ore-body.

Angle of hole.—40°.

Elevation of collar of hole.—Approximately 1,130 (sea-level datum).

Elevation of bottom of hole.—Approximately 882 (sea-level datum).

Vertical depth of hole.—248 feet.

Depth	Material drilled through.	Horizontal Width of Ore.	Analysis No.
Feet.		Feet.	
0·0– 40·0	Gabbro schist—three small granite dikes		
40·0– 48·0	Granite		
48·0– 51·0	Green schist		
51·0– 64·0	Granite		
64·0–126·0	Gabbro—small granite dikes		
126·0–142·0	Green schist		
142·0–151·0	Schist and gabbro		
151·0–157·0	Green schist—some pyrite		
157·0–162·0	Gabbro—some magnetite and pyrite		
162·0–169·0	Green schist		
169·0–210·5	Gabbro		
210·5–214·0	Granite		
214·0–226·0	Gabbro		
226·0–252·0	Green schist—bands of disseminated magnetites		
252·0–256·0	Green schist		
256·0–266·0	Low grade magnetite	7·5	
266·0–277·0	Magnetite—with white mineral	8·5	
277·0–279·0	Green schist		
279·0–282·0	Low grade magnetite		
282·0–343·0	Green schist—some magnetite and pyrite		
343·0–344·0	Magnetite		
344·0–351·0	Hard greenstone somewhat schistified		
351·0–366·0	Magnetite	11·5	
366·0–386·0	Gabbro with disseminated magnetite	15·0	
End.			

Diamond Drill Hole No. 5.

Location.—Near west boundary of AL26; about three-quarters of a mile S.W. of Hole No. 4.

Direction of hole.—N. 37° W.

Angle of hole.—45°

Elevation of collar of hole.—1,187 (sea-level datum).

Elevation of bottom of hole.—681 (sea-level datum).

Vertical depth of hole.—506 feet.

Depth.	Material drilled through.	Horizontal Width of Ore.	Analysis No.
Feet.		Feet.	
0·0–174·0	Gabbro and green schist with some magnetite and pyrite	....	
174·0–225·0	Gabbro with a little pyrite	....	
225·0–247·0	Schist	....	
247·0–266·5	Magnetite—6″ of quartz and 3″ of schist	14·0	*16
266·5–268·5	Low grade magnetite	1·5	
268·5–300·0	Schist with a little disseminated magnetite	....	
300·0–305·0	Quartz and green schist	....	
305·0–308·0	Low grade magnetite	2·1	
308·0–311·0	Quartz and green schist	....	
311·0–314·0	Low grade magnetite	2·1	
314·0–333·0	Green schist	....	
333·0–340·0	Magnetite	5·0	
340·0–344·0	Good low grade magnetite	2·8	
344·0–420·0	Gabbro with disseminated magnetite.	....	
420·0–430·0	Schist with some pyrrhotite, chalcopyrite and magnetite	....	
430·0–437·5	Magnetite with some pyrrhotite, chalcopyrite and pyrite	5·3	
437·5–440·0	Green schist	....	
440·0–457·0	Magnetite with a little pyrite in fissures	12·0	*17
457·0–470·0	Green schist	....	
470·0–472·0	Magnetite	1·4	
472·0–500·0	Green schist	....	
500·0–502·0	Magnetite	1·4	
502·0–515·0	Gabbro and green schist carrying some magnetite and pyrite	....	
515·0–516·0	Magnetite	....	
516·0–530·0	Green schist carrying some magnetite	....	
530·0–532·0	Magnetite	1·4	
532·0–543·0	Gabbro carrying some magnetite and pyrite	....	
543·0–566·0	Magnetite	1·6	*18
566·0–716·0 End.	Dark gabbro with disseminated magnetite.	....	

Diamond Drill Hole No. 6.

Location.—On AL28, 300 feet west of the east boundary; about five-eighths of a mile S.W. of Hole No. 5.

Direction of hole.—N. 19° E.

Angle of hole.—55°.

Elevation of collar of hole.—1,230 (sea-level datum).

Elevation of bottom of hole.—837 (sea-level datum).

Vertical depth of hole.—393 feet.

Depth.	Material drilled through.	Horizontal Width of Ore.	Analysis No.
Feet.		Feet.	
0·0– 40·0	Coarse gabbro with a little magnetite and pyrite—stringers with quartz, siderite, pyrrhotite and chalcopyrite		
40·0–180·0	Hard fine-grained gabbro carrying magnetite, pyrite and epidote.		
180·0–191·0	Schist with 8″ of pyrite and quartz		
191·0–266·0	Hard fine-grained gabbro carrying epidote and a little magnetite.		
266·0–270·0	Green schist		
270·0–280·0	Gabbro with some magnetite and pyrite		
280·0–288·0	Green schist		
288·0–288·7	Magnetite		
288·7–290·0	Green schist		
290·0–292·0	Light coloured schist with pyrite		
292·0–320·0	Green schist		
320·0–399·0	Gabbro schist with some magnetite and pyrite		
399·0–406·5	Magnetite	4·3	
406·5–415·0	Green schist with bands of siderite		
415·0–419·5	Green schist		
419·5–422·0	Magnetite	1·4	
422·0–424·0	Schist carrying magnetite and a little pyrrhotite		
424·0–429·0	Magnetite	3·0	*19
429·0–442·0	Low grade magnetite	7·5	*20
442·0–443·0	Green schist		
443·0–458·0	Low grade magnetite	8·6	
458·0–480·0	Green schist with stringers of quartz and a little magnetite		
End.			

Diamond Drill Hole No. 7.

Location.—On AL29, 150 feet west of the S.W. corner of AL28; about half a mile S.W. of Hole No. 6.

Direction of hole.—N. 50° W.

Angle of hole.—40°.

Elevation of collar of hole.—1,247 (sea-level datum).

Elevation of bottom of hole.—937 (sea-level datum).

Vertical depth of hole.—310 feet.

Depth.	Material drilled through.	Horizontal Width of Ore.	Analysis No.
Feet.		Feet.	
0·0– 17·0	Coarse gabbro with a little magnetite		
17·0– 48·0	Fine-grained gabbro with a little magnetite and pyrite		
48·0–108·0	Gabbro schist with a little magnetite		
108·0–171·0	Anorthosite carrying a little pyrite		
171·0–174·0	Schist carrying magnetite and pyrrhotite		
174·0–207·0	Anorthosite grading into gabbro schist		
207·0–239·0	Gabbro		
239·0–279·0	Gabbro schist—carrying some magnetite, pyrite, pyrrhotite and epidote		
279·0–306·0	Hard green schist carrying magnetite and pyrite		
306·0–322·0	Hard dark rock with much epidote		
322·0–350·0	Green schist with light coloured bands—carries some pyrite		
350·0–355·0	Magnetite		
355·0–360·0	Narrow bands of magnetite and a light coloured mineral (siderite?)	4·0	*21
360.0–363·0	Green schist with light coloured bands		
363·0–368·0	Low grade magnetite—A little pyrite in cracks	4·0	
368·0–371·0	Quartz vein with siderite		
371·0–394·0	Disseminated magnetite with small stringers of quartz, siderite and pyrite	17·6	
394·0–416·0	Soft light coloured schist		
416·0–482·0	Dark gabbro schist with disseminated magnetite		
End.			

Character of the Ore.

The ore may show any gradation between a gabbro carrying disseminated magnetite, and an almost pure magnetite carrying little or no gangue of ferro-magnesian minerals and feldspar. The different grades may occur either in separate bodies, or all may be found in a single deposit. The purer segregations are often bordered by leaner material and may pass more or less imperceptibly into a highly magnetitic gabbro; usually, however, the transition from ore to rock is rapid, and there is little or no difficulty in fixing the line of demarcation even when the ore is low grade and the rock carries disseminated magnetite. Individual segregations are of all sizes and are found as blebs, patches, bands, and elongated lenses through the iron-bearing rock.

The purer ore is generally massive, even when the enclosing rock is schistose; schistosity in the ore is more pronounced in the lower grades carrying a considerable amount of intermixed rock. The texture is medium to coarse-grained and fractured surfaces show crystalline cleavage faces. The bluish tinge, said to be characteristic of many titaniferous magnetites, was not noticed. Associated with the magnetite and magnetitic gabbro quartz, calcite, siderite, pyrite, pyrrhotite, and chalcopyrite occur in small quantities, usually as the filling in minute cracks and fissures. A little epidote is also found in places.

Analyses of a large number of samples show the best grade of ore to range from 40 to 50 per cent in iron, with an average of about 46 per cent; titanium dioxide from 10·0 to 27·5 per cent, with an average of about 20 per cent—equivalent to about 12 per cent titanium. Silica will average under 5 per cent, alumina about 2·8 per cent, lime about 1 per cent, and magnesia 2·0 per cent. Phosphorus is low, generally under 0·02 per cent. Sulphur also is low, but shows a slightly higher average in the drill core than in the outcrop samples.

The "low grade ore" carries from 30 to 40 per cent of iron with an average of about 13 per cent each of silica and oxide of titanium. The phosphorus, in contrast with that in the purer magnetite, is high—up to 2·4 per cent, and appears to vary, roughly, inversely with the iron.

Vanadium up to 1 per cent has been determined in specially selected samples.

The following table gives the composition of a number of samples taken from surface exposures and diamond drill cores.

TABLE OF ANALYSES.

OUTCROP SAMPLES.

Analysis No.	Fe.	SiO_2	TiO_2	P.	S.	Analyst.
1	48·45	7·35	26·03	0·05	0·05	Analysis furnished by Dr. W. L. Goodwin.
2	44·04	6·76	17·21	0·004	0·121	H. A. Leverin, Mines Branch Laboratory.
3	46·70	6·50	20·50	0·02	0·04	Analysis furnished by Dr. W. L. Goodwin.
4	46·60	2·47	27·54	0·029	0·041	LeDoux & Co., N.Y., furnished by Dr. W. L. Goodwin.
5	44·81	3·14	20·70	0·003	0·120	H. A. Leverin, Mines Branch Laboratory.
6	47·62	3·00	19·29	0·004	0·100	" " "
7	32·35	12·41	9·65	1·320	0·116	" " "
8	42·82	6·66	19·28	0·005	0·065	" " "
9	34·51	12·20	14·28	1·380	0·048	" " "
10	32·10	16·00	10·71	1·360	0·071	" " "
11	44·92	5·30	17·86	0·006	0·041	" " "
12	50·03	2·40	10·34	0·005	0·322	" " "
13	49·36	3·74	15·71	0·005	0·041	" " "

DRILL CORE SAMPLES.

Analysis No.	Fe.	SiO_2	TiO_2	P.	S.	Analyst.
14	45·60	3·36	24·00	0·005	0·116	H, A. Leverin, Mines Branch Laboratory.
15	24·97	29·82	6·75	1·296	0·140	" " "
16	46·75	4·14	23·40	0·004	0·101	" " "
17	44·64	3·40	18·00	0·004	0·635	" " "
18	45·50	4·50	24·00	0·004	0·371	" " "
19	35·38	8·24	18·60	0·008	0·405	" " "
20	30·85	12·26	11·40	2·405	0·100	" " "
21	39·43	3·68	22·20	0·005	0·407	" " "

No. 1 is the analysis of a ton lot from AL17.
No. 2 is an average sample taken across a 20-foot outcrop on AL17.
No. 3 is the analysis of a bulk sample from AL17 and AL18.
Nos. 4 and 5 are from a 32-foot outcrop on the line between AL26 and AL27.
No. 6 is an average sample from a 10-foot outcrop on the "south ore-body" on AL25.
No. 7 is an average sample from a low-grade outcrop on the east side of AL27 ("north ore-body").
No. 8 is an average sample across 20 feet of "high-grade" magnetite on AL26 ("north ore-body").
No. 9 is an average sample across 25 feet of "low-grade" magnetite on AL26 ("north ore-body"). lying alongside the band from which No. 8 was taken.
No. 10 is an average sample across 12 feet of low-grade on AL27.
No. 11 is an average sample across a 12-foot outcrop on the "south ore-body" on AL26.
No. 12 is an average sample across a 20-foot outcrop on 182P. (west end of range).
No. 13 is from an outcrop 100 to 150 feet long, with an average width of about three feet, on H.P. 96 at the extreme east end of the range.
No. 14 is from diamond drill hole No. 2, across 8 ft. of ore, about 150 ft. vertically below the surface.
No. 15 is from diamond drill hole No. 2, about 300 ft. vertically below the surface.
No. 16 is from diamond drill hole No. 5, across 14 ft. of ore, about 215 ft. vertically below the surface.
No. 17 is from diamond drill hole No. 5, across 12 ft. of ore, about 376 ft. vertically below the surface.
No. 18 is from diamond drill hole No. 5 across 16 ft. of ore, about 460 ft. vertically below the surface.
No. 19 is from diamond drill hole No. 6 across 3 ft. of ore, about 365 ft. vertically below the surface.
No. 20 is from diamond drill hole No. 6, across 7·5 ft. of ore, about 375 ft. vertically below the surface.
No. 21 is from diamond drill hole No. 7, across 4 ft. of ore, about 230 ft. vertically below the surface.

Extent and Nature of the Deposits.

The iron-bearing belt has been traced by means of outcrops, and dip needle readings over the drift-covered areas, for a distance of about 14 miles. The great linear extent is not due to the presence of a single large ore-body, but to a series of narrow lens-shaped deposits standing vertically, end to end, and separated from one another by country rock; the intervening rock is either practically barren, or may carry more or less disseminated magnetite. On parts of the range the lenses occur so close together as to form for a considerable distance an almost continuous ore-body; over the greater portion of it, however, the segregations rich enough to be called ore appear to be small and separated from each other by wide intervals. One of the sections of the range where the richer segregations lie close together crosses 181P, 182P, and 183P, north of Seine bay; another occurs north of the southwest arm of Bad Vermilion lake, running, roughly, from AL19 to AL27—a distance of about 2½ miles. It is on these two sections that most of the little exploratory work has been done. Between them, and beyond them at either end, the deposits, so far as known, appear to be scattered and less promising.

181P, 182P, and 183P.—Ore of fair width and grade is to be seen in natural outcrops and old trenches scattered at comparatively short intervals across the greater part of these three locations. The widest showing of good ore found on the range—something over 60 feet—is said to have been exposed in one of the trenches on 182P. In the present condition of the trenches this measurement could not be confirmed, but exposures were seen up to 30 feet in width with only one wall exposed. The analysis of an average sample taken across a 20-foot outcrop on 182P is given in the table of analyses (No. 12).

AL19 to AL29.—On the section of the range from AL19 to AL29 six holes, the details of which have been given above, were drilled across the deposits in 1917. All the holes passed through bands of good ore, varying in width from 4 to 16 feet, together with much material of lower grade. The deepest hole, No. 5, located on the line between AL26 and AL27, after passing through several narrower bands, cut 16 feet of good ore (analysis No. 18) 460 feet vertically below a 32-foot outcrop on the surface, and thus proved the deposits to extend to a depth of at least 321 feet below the level of Seine bay. The two holes on AL28 and AL29 were put down to test the range where it is hidden under a sand plain, and where the magnetic survey indicates only small, scattered ore-bodies. Each hole was pointed to pass under one of the areas of high magnetic attraction found at the surface, and the results obtained confirm the deductions made from the magnetic readings.

The information afforded by outcrops and by the drill hole records, throw more light on the width of the deposits and their occurrence at depth than it does on their length and continuity. The most definite information available on these last two points is that derived from a study of the magnetometric map. A detailed description of the part of the range actually surveyed, i.e., from AL25 to AL29, both inclusive, based on information deduced from the magnetic maps and supplemented by that afforded by natural exposures is as follows:—

Judging from the magnetic readings and by the outcrops, a well marked, almost continuous line of magnetic deposits, with a general trend of S. 60° W. lies along the north side of the iron-bearing belt from the east boundary of AL25 to the middle of AL27. The outcrops of this string of lenses, which has been termed locally the "north ore-body," are found along a narrow bench on the hillside at an elevation of about 130 feet above Bad Vermilion lake. Lower down on the hillside, south of this chief zone of deposits, smaller concentrations of magnetite, many of them mere blebs or pockets, occur scattered over a width of 300 or 400 feet. Some of the larger of these show a tendency to a roughly linear arrangement parallel to the "north ore-body" and have been named, locally, the "south ore-body." None of these small irregularly scattered deposits were noticed occurring to the north of the "north ore-body" which, on this part of the range at least, seems to form a clean cut boundary to the iron-bearing belt on its north side.

Crossing from east to west, mining locations AL25, AL26, and the east half of AL27, we find on the "north ore-body" at the east boundary of AL25 a lens of magnetite about 100 feet in length, indicated by the magnetometric map. An outcropping on this deposit shows 7 feet of good ore, alongside an undetermined width of low grade.

This 100-foot lens is followed to the west by two longer lenses, having indicated lengths of 400 feet and 200 feet, respectively. On neither of these were solid outcrops found where the width of ore could be measured and samples taken. Both are covered throughout by broken ore and rock or by earth.

The next lens, or a series of linked lenses, to the west, has a total length of about 900 feet; the boundary between AL25 and AL26 crosses it about 300 feet from its west end. An outcrop, just east of the line between AL25 and AL26, shows about 25 feet of mixed magnetite. A number of smaller exposures show some good ore, but with one or both walls hidden by drift so that the widths at these places could not be measured. The deposit, like those previously mentioned, is, for the most part, hidden under a talus of broken rock and ore.

A second group of closely linked lenses, also about 900 feet in length, comes in to the west after an interval of about 400 feet. The first 750 feet of this is on AL26, the remaining 150 feet is on AL27. Outcrops on this deposit show the greatest width of ore found on the range east of Seine bay. One, 450 feet east of the line between AL26 and AL27, shows 45 feet; 20 feet of it is comparatively pure magnetite (analysis No. 8) alongside 25 feet of leaner material (analysis No. 9); another, show-

ing 32 feet of solid magnetite, occurs in a shallow trench where the deposit crosses the boundary between AL26 and AL27. Diamond drill hole No. 5 passes 460 feet vertically below this last, where it cut 16 feet of magnetite.

On the east half of AL27 the magnetic survey indicates the presence of two further lenses of considerable length, lying in line, to the west, with those already described. The more easterly of the two is 600 feet long; the other 300 feet. On the first, outcrops of low grade ore 12 to 15 feet wide are to be seen (analyses Nos. 7 and 10); the second is completely hidden under a sand plain.

From the middle of AL27 to the west boundary of AL29 the iron range is almost entirely hidden under sand plains, and the magnetometric map indicates only small and scattered deposits of magnetite. Diamond drill holes Nos. 6 and 7 were put down to test more promising localities in this area, with rather discouraging results Analyses Nos. 19, 20, and 21 are from these holes.

All the deposits so far described form part of the "north ore-body." Roughly parallel and from 150 to 250 feet south of the latter, across AL26 and the western part of AL25, numerous outcrops of deposits on the "south ore-body" occur. These show magnetite in bands from 2 to 20 feet wide, but, judging from the magnetic map, the length of the individual deposits in no case exceeds 150 feet, and they are separated from each other by considerable stretches of barren rock.

The magnetometric survey was not extended eastward beyond the east boundary of AL25, but numerous outcrops would appear to indicate that magnetite deposits of considerable length follow each other closely as far as AL19. From AL19 to the eastern extremity of the range the indications are not promising.

Conclusion.

Even were the iron content of these magnetites considerably higher than it is their titanium content would effectually debar them from use as iron ores in the blast furnace. Their titanium content, on the other hand, is too low for them to be regarded favourably as a source of titanium. Should, however, a method for the utilization of material of this nature be devised in the future there are, no doubt, large quantities available in the Seine Bay deposits. Much more work would have to be done on them, though, before even approximate tonnage estimates could be made, or the proportions of the different grades determined.

NON-METALLIFEROUS MINES DIVISION.

I

LIMESTONES OF ONTARIO.

Howells Fréchette, *Chief of the Division.*

During the field season 1917, an investigation of the limestones of the Province of Ontario was undertaken. Limestone areas along the principal lines of transportation, and near the main consuming centres, as well as many outlying deposits, were examined and sampled. Practically all the operating quarries and many that were temporarily idle were visited. Certain sections in central and northern Ontario which were not visited this year will be included in the field work for 1918.

The production of limestone and lime is far below the pre-war output. Many quarries are shut down, and others are operated by reduced forces. This is due, principally, to curtailed building operations. A further cause for reduced output was the withdrawal, during part of the summer, of gondola and hopper cars from the stone service, excepting where the limestone was for use in munitions works.

Samples were not taken at all quarries; but from such as would indicate the nature of the rock available in the various sections of the Province. Numerous analyses from certain localities are on record in Government reports. These will be made use of when compiling the data for the final report, and will thus fill in the required information for certain districts which may appear to have been neglected in this preliminary report.

All analyses of samples collected were made by Mr. E. A. Thompson of the Mines Branch.

Renfrew County.

Very little limestone and no marble quarrying was in progress at the time of my visit. Lime was being produced at Renfrew by J. A. Jamieson, and at Eganville by the Standard Chemical, Iron, and Lumber Co., Ltd., as well as at two or three small pot kilns which were operated intermittently during the summer. Over the greater part of Renfrew county the exposed rocks are those of the Hastings series, the Palæozoic being represented by comparatively small areas.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
1	6·10	0·14	2·06	87·64	3·48	49·10	1·66
2	1·40	0·64	2·76	90·66	4·39	50·79	2·10
3	2·40	0·43	1·37	92·04	3·33	51·57	1·59
4	5·10	0·50	0·70	88·52	5·10	49·60	2·44
5	2·10	0·70	4·90	86·73	5·46	48·60	2·61
6	0·40	0·28	0·32	55·04	43·83	30·84	20·96
7	1·65	0·29	0·41	88·20	9·17	49·42	4·39
8	1·10	0·42	0·78	92·60	4·50	51·88	2·15
9	2·60	0·56	1·24	53·54	41·20	30·00	19·72
10	0·70	0·44	0·16	53·54	44·89	30·00	21·48
11	2·30	0·84	2·36	91·27	3·18	51·13	1·52

Sample 1 is an average of the 12-foot face in the quarry of Wm. Markus, Ltd., at Pembroke (lot 12, concession I, Pembroke township). The stone is fine-grained, bluish-grey, with thin shale partings between some beds. Most of the beds are thin, though some are as much as 20 inches in thickness. This stone is probably of Chazy age.

Sample 2 is an average of the crystalline limestone exposed in a small quarry belonging to Albert G. Biederman, on lot 20, concession XIX, Wilberforce township. The stone is used exclusively for the burning of lime, which finds a small local market. The surrounding country is hilly, and the roads are poor.

Sample 3 is an average from the quarry of the Standard Chemical, Iron, and Lumber Co., Ltd., situated on the south side of the Bonechere river, immediately east of Eganville. The stone is fine-grained, brownish-grey, and heavily bedded, with very little shale between the beds. It is used for the production of lime. Two draw kilns are situated on the property, one of which was in operation when visited in July.

Sample 4 was taken from a small quarry on the farm of Peter McDougald to the northeast of Douglas station on the C.P.R. There is an extensive exposure of brownish-grey, close-grained Chazy limestone.

Sample 5 is an average from a small quarry belonging to John M. Jamieson, on lot 10, concession X, Ross township. The stone, which is used for lime burning, is a rather fine-grained grey crystalline limestone, containing a small amount of mica and graphite disseminated through it. A pot kiln is situated alongside the quarry.

Sample 6 is an average of the white, crystalline dolomite, exposed above water in the quarry of the Renfrew White Granite Co., Ltd., on lot 19, concession VI, Ross township. The stone is coarsely crystalline, and is almost a pure white, with a few shafts of white actinolite shot through it. A large marble sawing and polishing mill has been installed on the property, and a spur line constructed from Haley Station to the quarry. Only a small quarry was developed, and is now idle. Similar stone was observed on neighbouring lots.

Sample 7 is representative of the rather fine-grained, close-textured, grey, crystalline limestone in the quarry of J. A. Jamieson on lot 13, concession III, Horton township. The stone from this quarry which is quite extensive, is used for building purposes. The Corporation of Renfrew operates a quarry on the corresponding lot in concession II, from which stone for road work is obtained.

Sample 8 is an average from the quarry of J. A. Jamieson, on lot 5, concession II, Horton township. The stone, which is coarse-grained crystalline limestone, is used for lime burning. Two draw kilns are operated by Mr. Jamieson within the town of Renfrew; but only one was in use at the time of my visit in July.

Sample 9 is of a coarse-grained, crystalline dolomite, exposed by the roadside on lot 28, concession VI, Bagot township.

Sample 10 was taken from the shore of White lake on lot 1, concession I, Bagot township. It was rather badly weathered, but would indicate, nevertheless, that the rock is a very pure dolomite and well worth considering for exploitation. It is a marble of very fine texture, and capable of taking a high polish. This surface sample was cream coloured, with darker stains along cracks and cavities. These latter should be much less in evidence, if not entirely absent, in the unweathered rock.

Sample 11 is an average of the 15-foot face of the quarry of the Canada Lime Co., Ltd., on lot 18, concession XIII, McNab township. The stone, which is burned for lime in a draw kiln, is a rather fine-grained, dark grey limestone, of Black River age. The quarry has a face of about 150 feet long and 15 feet high. There are numerous extensive outcrops of similar stone on nearby lots.

To the southeast of Braeside there are several old quarries in limestone of Chazy age. The stone is thin bedded, and carries considerable shale.

Lanark County.

Exposures of the stratified Palæozoic rocks in Lanark, are limited to the eastern portion of the county. The western part is occupied by crystalline rocks of the Hastings series.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
12	4·90	0·41	0·79	90·66	2·88	50·80	1·38
13	3·00	0·55	0·65	92·44	1·51	51·80	0·72
14	5·60	0·56	1·94	89·94	1·51	50·28	0·72
15	2·80	0·42	0·78	88·52	7·27	49·60	3·48
16	1·70	0·28	0·72	87·80	9·38	49·19	4·48
17	2·08	0·69	0·25	54·80	41·30	30·72	19·76

Sample 12 was taken from an exposure of heavily bedded Black River limestone on lot 23, concession XII, Pakenham township. The sample is representative of the two upper beds, which are each about 30 inches thick. This stone, which is fine-grained, and dark grey, is exposed over a considerable area where quarrying could be easily done. It is within a short distance of the C.P.R. main line.

Sample 13 is an average taken from the 30-foot face of a quarry situated, to the east of the river, on the outskirts of the village of Pakenham. The stone, which is of Black River age, is fine-grained, dark grey. With the exception of the middle 15 feet the limestone is in rather heavy beds. The output from this quarry, which is now idle, has been used for building and road purposes.

Sample 14 was taken from the lower beds of an old quarry north of Almonte, on the outskirts of the town, along the face of a ridge that parallels the railway, on lot 17, concession IX, Ramsay township. This stone is a fine-grained, blue limestone, which weathers on the surface to light buff. The upper portion of the quarry face is made up of thin layers, interbedded with considerable shale, hence was not sampled. A short distance to the northeast, stone for road metal was being quarried.

Sample 15 is representative of the blue-grey crystalline limestone being quarried on lot 20, concession V, Ramsay township, for road metal. The stone which is of medium grain is very nicely banded, and should, on polishing, produce a very attractive marble.

Sample 16 is an average of the crystalline limestone from the quarry being operated by W. M. Cameron on lots 8 and 9, concession IV, Ramsay. This stone is hauled to Carleton Place, a distance of about 4 miles, where it is calcined in a draw kiln. The lime finds not only a local market, but is shipped, by rail, to Ottawa and other points.

Sample 17 is representative of the dolomite quarried on lot 12, concession X, Beckwith, by Daniel McNeely, of Carleton Place. The stone is very dark brown, finely granular, and decidedly porous. Parks assigns this stone to the Beekmantown formation.

Carleton County.

With the exception of a few exposures of the crystalline rocks of the Hastings series in the extreme northwest corner of the county, the rocks are all of Palæozoic age. High calcium, grey, crystalline limestones are exposed at numerous points near Galetta and, at greater intervals, westward as far as Arnprior in Renfrew county.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
18	0·80	0·35	0·25	97·40	0·75	54·57	0·36
19	4·90	1·12	2·28	77·80	12·40	43·59	5·93
20	9·70	0·70	0·70	85·60	3·03	48·06	1·45
21	1·80	0·28	0·34	95·30	1·21	53·40	0·58
22	1·90	0·70	0·60	93·16	1·51	52·19	0·72
23	14·35	0·98	0·22	58·35	25·94	32·69	12·39
24	1·00	0·42	0·78	95·80	1·80	53·68	0·86
25	0·80	0·28	0·62	97·00	1·80	54·35	0·86

Sample 18 is an average of the lower beds exposed in McTernan's quarry on lot 21, concession IV, Torbolton township. Very little stone is now being taken from this quarry, though in the past large quantities of heavy building stone have been taken out. The upper 10 feet of the face shows heavily bedded, fine-grained, dark grey limestone. The lower 10 feet, which is light grey, coarser in texture and apparently purer, is now used for lime burning. Two pot kilns are situated a short distance from the quarry. There are extensive exposures of similar stone on adjacent lots.

Sample 19 is representative of the very fine-grained, argillaceous limestone, from a small quarry on the east half of lot 3, concession XII, Goulburn township. The stone varies from light to dark blue, has a conchoidal fracture, and occurs in beds from 3 to 10 inches thick, between which are thin partings of shale. It is employed for local use only, and the quarry is operated only at odd times.

Sample 20 is an average of the 33 feet of strata exposed in the quarry of the Rideau Canal Supply Company, situated just west of Ottawa on the Merivale road. The stone, which is of Black River age, is fine-grained, dark blue-grey to brownish. This quarry produces a considerable tonnage of crushed stone for the Ottawa market.

Sample 21 is an average of the 30-foot face of Trenton limestone exposed in Thibault's quarry on the east side of the Rideau river at Hogs Back. The stone, which is light grey, and of medium grain, is heavily bedded. The entire product of the quarry is crushed for use in concrete.

Sample 22 is an average of the face of a small, old quarry on lot 3, concession III, Gloucester township (Rideau front).

Sample 23 was taken in the quarry of Charles Gamble on lot 24, concession I, Gloucester (Rideau front). The stone, which is heavily bedded, fine-grained, and tough, is of Beekmantown age. There are extensive exposures from which stone suitable for building, or road metal, could be obtained. The quarry has been idle for two years.

Samples 24 and 25 were taken from the quarry of H. Robillard and Son, on the south half of lot 22, concession I, Gloucester township (Ottawa front). This quarry, which is very large, has a face 16 feet high. Sample 24 represents the upper 10 feet, and 25 the lower 6 feet of the quarry. The upper stone is fine-grained, blue limestone, while the lower is brownish, and of a coarser texture. Two large kilns are situated beside the quarry. The entire plant was idle when visited in June.

In the vicinity of the above quarry are others of considerable size, none of which were in operation.

Russell County.

There are numerous exposures of stratified limestones in Russell county especially in the northern part, along low ridges which parallel the Ottawa river, and along a few of the stream beds in the southern part of the county.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
26	3·40	0·14	0·56	93·10	2·23	52·16	1·07
27	3·60	0·28	1·12	92·60	1·50	51·88	0·72
28	4·77	0·70	0·34	92·08	2·56	51·59	1·22
29	2·27	0·69	0·37	93·52	2·88	52·39	1·37

Sample 26 is an average of the upper 75 feet of an old quarry, known as Stewart's quarry, situated a short distance south of Rockland. An immense quantity of very heavy dimension stone has been quarried here, much of which lies in great piles along old railway sidings at the quarry. The beds, 90 feet of which are exposed, are, for the greater part, very thick. The stone is fine-grained, dark grey to blue, with black seams parallel to the bedding. Two draw kilns were operated at one time on waste rock. The entire plant has been closed for a number of years.

At mill No. 1, Rockland, the W. C. Edwards Company operates a small quarry from which broken stone is obtained for local use.

Sample 27 is an average of the upper 6 feet of F. Beauchamp's small quarry, Clarence Creek. The stone in the upper 6 feet is rather thin bedded, dark grey, and of varying fineness in texture. The lower 4½ feet, is lighter in colour, coarser, and in beds up to 2 feet thick. The stone is used locally for building and for lime burning in a small pot kiln. Operations are on a very small scale.

Sample 28 was taken in the building stone quarry of Eugene Bruyere, lot 7, concession VII, Russell township. The stone is very dark grey, fine textured, and apparently sound in most of the beds. Sample 29 is from a small quarry near Mr. Bruyere's house, on the same lot. At one time this stone, which is coarse-grained, and light in colour, was used for making lime in a small kiln which is now in ruins. Neither of these quarries has been operated recently. The main line of the Ottawa and New York railway runs between the two quarries.

On nearby lots exposures of similar limestones were seen.

At various points on the Castor river, limestone outcrops along the steep shores and in the bed of the stream. Several small quarries have been opened to obtain stone for local foundation building, for road metal, and to supply small pot kilns; but no sites suitable for extensive quarrying were observed.

PRESCOTT COUNTY.

There are numerous exposures of limestone of Trenton, Black River, and Chazy age in the northern part of this county. Along a number of low ridges, generally lying approximately east and west, limestone outcrops may be seen at short intervals, for distances, in some cases, of several miles.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
30	3·40	1·26	2·54	91·14	0·50	51·06	0·24
31	2·55	0·64	1·96	94·23	0·75	52·79	0·36
32	12·00	0·63	1·37	84·84	1·10	48·10	0·53
33	7·71	0·63	2·07	87·45	1·21	49·09	0·58

Sample 30 is an average of 29 feet of strata exposed in an old quarry, owned by R. C. Ross, on lot 28, concession I, Hawkesbury East. The stone, which is of Chazy age, is light grey, and of moderate coarseness, heavily bedded, and free from shale partings. A large quantity of heavy dimension stone has been taken out for canal work. An analysis of one bed, quoted by Parks[1] shows it to be considerably purer than this average sample.

Sample 31 is representative of the dark blue-grey, close-grained, Black River limestone in the quarry of S. D. Stevens on lot 10, concession III, Hawkesbury West. The stone lies in heavy beds, some of which show black streaks parallel with the bedding. The product of the quarry is broken stone and stone for lime burning in a small draw kiln.

Sample 32 is an average from a small quarry on lot 6, concession IV, Alfred township, owned by James Lett. The limestone which is of Chazy age is thinly bedded, close-grained, and dark blue. The quarry is opened in a long low ridge extending for several miles east and west.

Sample 33 was taken from the face of Winning's quarry on lot 9, concession VI, Plantagenet North, immediately to the north of the Canadian Pacific railway, near Plantagenet station. The stone, which is variable in grain and colour, is of the Black River formation. Between the beds, which are heavy, there is a small amount of shale. The quarry has been idle for several years.

ST. LAWRENCE RIVER COUNTIES.

Although, in the past, there has been some extensive quarrying of limestone in several of the counties fronting on the St. Lawrence, there has been practically none in recent years, except in the immediate neighbourhood of Kingston. Even at Kingston, the production has been greatly reduced, and a number of quarries closed. At Delta, in Leeds county, a limited amount of crystalline limestone is produced for lime burning.

Glengarry County.

The rocks in Glengarry county are masked by a covering of clay, sand, loam, and peat, except in a few scattered localities.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
34............	6·41	0·56	0·24	89·59	3·80	50·19	1·82
35............	2·50	0·70	0·30	94·58	1·51	52·98	0·72

Sample 34 is an average of the 20-foot face, in an old quarry of considerable size, on lot 6, concession X, I.L., Charlottenburg township, 2 miles due south of Apple Hill. The beds are very heavy and have yielded a large quantity of heavy dimension stone. The stone is fine-grained, very dark, blue-grey, and is somewhat "shaky." According to Ells' geological map of this area, it is of Trenton age. Near the quarry are the ruins of two pot kilns, and large heaps of culled stone and spalls.

Sample 35 is representative of the stone in a couple of small, old quarries on lots 6 and 7, concession II, Lochiel township. The rock which is apparently of the Black River formation, is very dark blue to brownish-grey, close-grained, occurring in rather heavy beds, some of which show thin black seams along the planes of bedding.

[1]Building and Ornamental Stones of Canada, Vol. I, Mines Branch publication No. 100, p. 189.

Stormont County.

The rocks of Stormont, as in Glengarry county, are largely hidden, and very little quarrying has been done except in a small area one mile north of Mille Roches. Here, several large quarries in Black River limestone were worked ten or more years ago, when a great quantity of heavy dimension stone was quarried for use in construction work on the St. Lawrence canals. These quarries are situated in low ground, and as the pits are full of water, very little of the rock could be seen in place. Immense piles of culls and quarry waste nearby, however, indicate the nature of the stone.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
36.............	2·80	tr.	0·20	94·58	1·51	53·00	0·72
37.............	2·60	0·84	0·36	93·87	2·26	52·59	1·08

Sample 36 is an average of the waste piles at the quarry on lot 23, concession III, R. 4, Cornwall township. The stone is very dark, blue-grey, in beds up to 4 feet or more in thickness. Shale is evidently present between some beds, as considerable was observed mixed with the other waste. There is probably in the neighbourhood of 10,000 tons of waste rock at this quarry, which might be employed for road metal, concrete work, riprap, or lime burning. The stone in the adjacent quarries is apparently the same.

Sample 37 was taken on lot 8, concession XII, Finch township, where quarrying operations had been commenced. The stone, which is of Black River age, is fine-grained, dark blue, occurring in heavy beds practically free from shale. The site is excellently adapted for a quarry, as it is high, gently sloping ground, has little overburden, and is adjacent to the railway. There are large exposures of this limestone throughout the neighbourhood.

Dundas County.

There are many rock exposures in the county of Dundas. Numerous small quarries have been worked at various times, usually for the production of building stone for purely local trade. The limestones range from the impure, dolomitic, Beekmantown in the western half of county, to the Black River high calcium limestone along the northeastern margin. No sample was taken of the Beekmantown stone.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
38.............	10·80	0·72	0·48	80·66	7·58	45·19	3·62
39.............	5·61	0·70	0·10	89·59	3·78	50·20	1·81
40.............	4·70	0·88	0·32	92·44	1·51	51·80	0·72

Sample 38 is an average from a small, old quarry on lot 31 or 32, concession VII, Williamsburg township. The stone is of Chazy age, fine-grained, blue, and is in beds up to 10 inches thick. The overburden is very light.

Sample 39 is representative of the 5 feet of stone exposed in an old quarry on lot 19, concession VII, Williamsburg. The stone is dark blue, rather "shaky," and is of Black River age. The beds, which are about 1 foot thick, hold some shale on their partings.

Sample 40 is an average from the Corporation quarry, situated about one-half mile south of Winchester station of the Canadian Pacific railway. The stone is fine-grained, dark blue, in heavy beds; but is badly jointed and twisted. It is of Chazy age.

Grenville County.

The only limestones observed in this county are the dolomitic limestones of Beekmantown age. In the northern part of the county there are extensive areas of very light overburden where many exposures of flat lying stones are to be seen. Along the St. Lawrence front outcrops are less frequent. At Prescott, between the road and the river, lie some old quarries from which a large amount of building stone has been taken. Other old quarries were visited at various points in Augusta and Edwardsburg. They were in all cases very small.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
41	9·00	0·43	1·17	49·96	38·30	28·00	18·30
42	2·61	0·98	0·82	63·88	31·51	35·80	15·05

Sample 41 was taken in a rock cut on the Canadian Pacific railway, in which 10 feet of strata is exposed, opposite lot 2, concession I, Wolford township. The stone is fine-grained, and mostly thinly bedded, though one bed is 10 inches thick.

Sample 42 is representative of an old quarry on lot 17, concession II, Augusta township. The stone, though thinly bedded, is free from shale partings.

Leeds County.

The rocks of the northern half of this county are of Palæozoic age, while those to the south are of the older crystalline series.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
43	5·20	0·70	0·30	78·88	13·93	44·20	6·65
44	1·71	0·71	0·10	89·52	6·68	50·16	3·19
45	8·00	1·12	1·48	54·60	34·84	30·59	16·65
46	14·85	1·26	0·14	50·31	31·53	28·19	15·06

Sample 43 is representative of an exposure of fine-grained limestone near the road on lot 11, concession VIII, North Crosby, about 2 miles west of Westport.

Sample 44 was taken from the stock pile at the kiln of the Delta Lime Company, Limited, at Delta. The stone, which is a bluish crystalline limestone, is said to have come from a quarry on the opposite side of Lower Beverly lake.

Sample 45 is an average of the 10-foot face of an abandoned quarry on the south side of the Prescott road, about one mile east of the Brockville town limits. The

stone is very tough, hard, and fine-grained, and is grey when fresh, weathering brown. Some beds are 18 inches in thickness.

Sample 46 is representative of the stone exposed in a number of small openings on the farm of Geo. Sherwood, half a mile east of Brockville, on the north side of the Prescott road. The stone is similar to that of sample 45, but is of a slightly higher horizon.

These last two samples are representative of the stone from a number of small, old quarries in this district.

Frontenac County.

The Pre-Cambrian, crystalline rocks occupy the greater part of this county; the Palæozoic rocks appearing only in the extreme southern part. Within the area of crystalline rock there are numerous exposures of crystalline limestone. In the neighbourhood of Kingston and on the islands in the St. Lawrence, near Kingston, there are extensive exposures of stratified limestones, in which many quarries have been worked for building stone and road metal. At present very few of these quarries are being operated.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
47	7·25	0·42	0·18	87·07	4·84	48·78	2·32
48	27·60	1·12	1·13	41·76	26·82	23·39	12·81
49	2·70	0·56	1·04	90·66	5·15	50·80	2·46
50	4·10	0·70	0·50	93·10	1·97	52·16	0·94
51	2·40	0·55	0·25	93·51	2·42	52·39	1·16
52	4·40	tr.	0·20	86·74	7·57	48·59	3·62
53	4·10	0·56	0·84	55·68	38·93	31·20	18·58

Samples 47, 48 and 49 represent three grades of stone exposed in a large road cutting which was commenced near the Barriefield camp, east of Kingston. The stone from this cutting was used for various public works. No. 47 is a very fine-grained, brittle, brownish-grey limestone, at the base of the cutting. A 10½-foot section is made up of beds from 2 to 12 inches thick. Lying upon this, is 14 feet of heavily bedded, light buff, gritty, impure, dolomitic limestone, represented by No. 48. On this lies 12 feet of shaly limestone, and 6 feet of very fine-grained, brownish limestone; which in turn is followed by an undetermined thickness of shaly limestone. The upper 16 feet of stone exposed in the cut is a fine-grained, dark, heavily bedded limestone, of which No. 49 is a sample.

Sample 50 is an average of the 12-foot face in a small quarry on lot 4, concession II, Kingston township, from which road metal has recently been quarried. At one time this stone, which is dark brown, and very fine-grained, was used for building purposes. It is similar to much of the stone seen about Kingston.

Sample 51 was taken in an old quarry owned by Mrs. Luke Costello, on Wolfe island, about a quarter of a mile east of the wharf. This stone, though fine-grained, is by no means as fine as that exposed in the quarries in Kingston. It is very dark, brownish-grey, and carries interbedded shale in rather small quantities.

Sample 52 is representative of the white crystalline limestone in a small, old quarry owned by Arthur Kenyon, just east of Godfrey. The quarry, which is opened in a hillside, furnished stone to a small pot kiln. Several fairly large masses of quartz and a small amount of disseminated mica were observed in the quarry.

Sample 53 is an average of an abandoned quarry on lot 9, concession XII, Portland township. The stone, which is a crystalline dolomite, was burned for lime in a draw kiln, which is now dismantled.

CENTRAL ONTARIO.

While a certain amount of work was done in this area, it was insufficient to gain a proper conception of the limestone resources. Further work is to be done in 1918, therefore this district will be dealt with very briefly in the present report. The principal limestone quarrying is at Point Anne, in Hastings county, Massasagua point, Prince Edward county, and north of Kirkfield, in Victoria county; from which localities large quantities of broken and crushed stone were being shipped to Toronto. A limited amount of limestone for building was being quarried at Longford, and some stone for lime burning and road work, at Napanee.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
54	2·00	0·42	0·38	95·97	1·06	53·77	0·51
55	2·00	0·28	0·12	93·87	2·27	52·59	1·08
56	2·70	0·12	0·28	92·80	2·59	51·99	1·24
57	4·50	0·56	0·64	83·16	11·50	46·59	5·49
58	2·17	0·42	0·58	94·58	1·51	52·99	0·72
59	3·30	0·12	0·48	83·56	12·32	46·81	5·89
60	13·71	0·21	0·79	84·93	0·45	47·59	0·22
61	2·20	0·41	0·59	93·51	1·51	52·39	0·72
62	7·90	0·50	0·50	86·53	3·18	48·48	1·52
63	5·30	0·55	0·05	93·87	0·75	52·59	0·37
64	4·90	0·28	0·12	93·51	0·75	52·39	0·37
65	2·82	0·49	0·23	95·00	1·52	53·18	0·75
66	4·78	0·53	0·35	91·69	3·00	51·40	1·48
67	2·85	0·31	0·15	94·20	2·18	52·76	1·04

Sample 54 is representative of the stone in an extensive exposure on lot 35, concession VII, Ernesttown township, Lennox and Addington. This stone, which is brownish-grey, and very fine-grained, occurs in beds up to 2 feet thick. There is a small, old quarry on the property.

Sample 55 is an average of the stone quarried, by P. J. Bergin, on Roblin's hill east of Napanee, for lime burning. There are a number of quarries in this immediate neighbourhood, several of which are worked by Mr. Bergin for the production of building stone and road metal.

Sample 56 is representative of the lower 8 feet of the 23-foot face in an old, small quarry 2½ miles northeast of Napanee, near the highway bridge over the Napanee river. The stone is a medium-grained, grey limestone, carrying very little shale.

Sample 57 is an average of the 10-foot face of a small quarry on lot 13, concession I, Camden township, from which stone has been quarried recently for road building. The rock is light blue, very fine-grained, and apparently free from shale.

Sample 58 was taken in the old quarry of the Ontario Limestone and Clay Co., near Shannonville. The stone, which is light grey, and of fairly coarse grain, was used for lime burning in two modern draw kilns which are now partly dismantled.

Sample 59 is of white crystalline limestone, exposed immediately east of the Methodist church, in the village of Actinolite.

Sample 60 was taken from an exposure of white, crystalline limestone on lot 12, concession XIV, Hungerford township, the property of the Hastings Quarries Company. The stone varies in texture from very fine-grained to medium.

Sample 61 is an average from an old quarry on lot 12, concession XI, Hungerford township. The rock, which has been employed for structural purposes, is a very heavily bedded, dark, brownish-grey, close-grained limestone, of Trenton age.

Sample 62 was taken in a small quarry on lot 52, concession II, W. G. P., Sophiasburg, Prince Edward county, owned by John Doxisee. The stone is thin-bedded, medium fine-grained, blue-grey limestone, interbedded with a small quantity of shale.

Sample 63 was taken in the small quarry of James Bedborough on lot 23 or 24, concession III M. T., Hallowell township, Prince Edward county. The stone is rather coarse-grained, and occurs in thin beds with considerable interbedded shale.

Sample 64 is representative of 8 feet of coarse-grained light grey limestone exposed in a rock cut on the C.P.R., one mile east of Havelock, Peterboro county.

Sample 65 was taken from the surface of an exposure on the roadside near Preneveau, a couple of hundred yards east of the Ontario Rock Company's siding. The stone, which is dark brown, and fine-grained, occurs in heavy beds.

Sample 66 is an average of the 16-foot face of the Crushed Stone, Limited, quarry on lot 49, concession IX, Eldon township, Victoria county. The stone is a hard, tough, dark, blue-grey to brown-grey, fairly coarse-grained Trenton limestone. A small amount of shale was observed between some beds. The quarry, which is about 200 feet wide and 700 feet long, is situated on the North Portage road beside the Trent canal, and is served by a railroad siding from the Coboconk branch of the Grand Trunk. The entire output of the quarry is crushed in an up-to-date crushing plant which produces five sizes of crushed stone, stone flour, and pulverized agricultural limestone.

Sample 67 is an average of the 25-foot face of the old Canada Iron Corporation quarry, half a mile north of Longford in Rama township, Ontario county. The stone is light grey, hard, brittle, and of extreme fineness. This quarry, which is about 100 feet by 900 feet, furnished flux for the blast furnaces of the company. Near by are the extensive building stone quarries of the Longford Quarry Co., Ltd. At the time of my visit very little work was being done at these quarries.

SOUTHWESTERN ONTARIO.

In this section are included Simcoe, Peel, and the other counties to the south and west. Heavy overburden of clay, sand, and soil, covers the rocks over the greater part of this area. Along the Niagara escarpment, which extends from the Niagara river, past Hamilton, and thence northward to Collingwood, where it follows the Georgian Bay shore to the head of the Bruce peninsula, and for a limited distance on the west side of the escarpment, there are numerous exposures of limestone. Elsewhere, the heavy overburden hides the rock, except in the valleys of some of the larger streams, and in places along the shores of the great lakes.

PEEL COUNTY.

Along the Credit river and the side valleys leading to it, there are many exposures of dolomite. Several large and small quarries have been worked in the past. At present, only one quarry is in operation, that of the Contractors' Supply Co., Ltd. Their quarry is situated on the Canadian Pacific railway, about one mile north of Melville Junction. A modern lime plant is operated in conjunction with the quarry, producing both quick lime and hydrated lime. The two kilns are of the Eldridge type. Hydration is effected in a Clyde hydrator.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
68............	1·80	0·60	0·80	53·54	43·16	29·99	20·64
69............	14·30	1·68	1·52	45·68	36·90	24·59	17·65

Sample 68 is an average of the 25-foot face in the abovementioned quarry. The stone is very hard, light bluish to yellowish-grey. It is rather porous in some beds, and in others, compact.

Sample 69 was taken from some large, loose fragments at the base of the escarpment at Credit Forks, along the face of the old quarry of the Credit Valley Stone Company. An average sample could not be obtained, nor could the section exposed be properly examined, owing to the dangerous condition of the steep face of the old quarry.

HALTON COUNTY.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
70............	0·80	0·56	0·24	54·60	43·85	30·69	20·97
71............	2·43	0·36	0·12	55·35	41·65	31·00	19·93
72............	0·52	0·46	0·12	54·95	43·50	30·80	20·80
73............	0·81	0·53	0·21	55·80	42·40	31·25	20·30
74............	10·90	0·70	1·02	49·25	37·80	27·60	18·10

About 2 miles west of Milton, to the south of the Canadian Pacific tracks, cliffs of the Niagara escarpment rise to a considerable height above the level of the railroad, offering a splendid opportunity for quarrying the limestone exposed on the face. Two large quarries have been developed near this point: owned, respectively, by Christie-Henderson Co., Ltd., and D. Robertson and Co. The stone obtained from these quarries is burned for lime.

Samples 70 and 71 were taken in the quarry of Christie-Henderson Co., Ltd., on lot 3, concession VI, Nassagaweya township. The rock is very hard and tough, mostly light buff, but with irregularly distributed zones of dark blue stone. Sample 70 is an average of the buff, and sample 71 represents the blue stone. Three large draw kilns are operated at this quarry.

Sample 72 is an average of the stone used for lime burning from the quarry of D. Robertson and Co. on lot 3, concession VII, Nassagaweya township. The stone, which is light buff, is apparently not quite as hard as that of the Christie-Henderson quarry. Three large draw kilns are operated in conjunction with this quarry. At the base of the escarpment, a few beds of sandstone are exposed. These are quarried to a limited extent.

Sample 73 is an average of the stone in the Dolly Varden quarry of the Toronto Lime Co., Ltd., on lot 24, concession IV, Esquesing. The stone which is similar in appearance to that of the Christie-Henderson quarry in Nassagaweya township, is used for lime burning. At this quarry there is a battery of four large draw kilns, only one of which was in operation in October.

Sample 74 is representative of the lower thin beds in the old Limehouse quarry of the Toronto Lime Company, Ltd. This stone, which is dark blue, very hard, fine-grained, and dense, was at one time burned for the production of water lime. Overlying it, is light buff, heavily bedded stone, similar to that being quarried at Dolly Varden, 1½ miles to the west. In the immediate neighbourhood of this quarry are three draw kilns and the remains of eleven large pot kilns, all of which are idle.

WELLINGTON COUNTY.

The extensive outcroppings of high grade, Guelph dolomite make this county one of the most important centres of the lime and hydrated lime industry. Along the Grand river between Fergus and Elora, are a number of old quarries and small pot

kilns. A large quarry, owned by James Gow, is situated on the south side of the river, at Fergus. Two large draw kilns were operated in connexion with this quarry. Neither the kilns nor the quarry were in operation when visited. The quarry and plant of the Elora White Lime Company are situated on the north side of the river about one mile east of Elora. In September, this company was remodeling its plant, increasing its battery of kilns to five and installing a new Shaffer hydrator. At the junction of the Grand and Irvine rivers at Elora, the Wellington Lime Association at one time operated a large quarry and a lime kiln. The stone is similar to that of the Elora White Lime Company, an analysis of which is given below.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
75.............	1·00	0·35	0·05	54·60	43·02	30·59	20·57
76.............	1·00	0·35	0·05	54·25	43·32	30·40	20·71

Sample 75 is representative of the stone in James Gow's quarry. It is light buff, very fine-grained, and contains, in some beds, casts of shells.

Sample 76 is an average of the stone in the quarry of the Elora White Lime Company. The stone is a hard, cream-coloured dolomite, in beds about 1 foot thick. Some beds carry many fossil casts.

Along the river Speed, and the Eramosa—which flows into it, are many exposures of the Guelph dolomite. At Guelph there are a number of quarries, only one of which was being actively operated, that of the Standard White Lime Company, situated to the south of the city. The stone, which is a fine, granular, cream-coloured dolomite, is used for the production of quick lime and hydrated lime in the plant of the company. This consists of three large draw kilns and a Clyde hydrator. To the north-east of Guelph, on the Ontario Prison Farm, a quarry has been opened on the north side of the Eramosa river. A face has been developed 300 feet long, and about 30 feet high. The upper 20 feet is a buff, medium-grained dolomite. The lower 10 feet is a thin bedded, hard, cherty dolomite. At the quarry there are a crusher plant, one large draw kiln, and a Clyde hydrator plant. The quarry and plant were idle in 1917.

At Rockwood, the Eramosa river has cut a deep ravine, along which there are large exposures of dolomite. The quarry of E. Harvey, Limited, is situated on lot 4, concession IV, Eramosa township. Most of the beds are hard, buff and somewhat porous, though some are of a decided bluish cast. There are three draw kilns in connexion with the quarry, only one of which was in operation in September.

About 3 miles north of Hespeler, Christie-Henderson and Company operate a quarry, two lime kilns and a Clyde hydrator plant on the west of the river Speed. The stone is a light buff, heavily bedded dolomite, of medium grain. A 20-foot face has been developed for a length of about 500 feet.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
77.............	0·70	0·14	0·06	53·18	44·02	29·89	21·05
78.............	0·50	0·14	0·06	53·89	43·55	30·19	20·83
79.............	0·80	0·40	0·20	54·60	43·99	30·59	21·03
80.............	1·00	0·28	0·12	53·54	45·09	29·99	21·56

Sample 77 is an average from the quarry of the Standard White Lime Co., Ltd., at Guelph.

Sample 78 is an average of the upper 20 feet of the Prison Farm quarry, Guelph.

Sample 79 is an average from the quarry of E. Harvey, Ltd., at Rockwood.

Sample 80 is an average from the quarry of Christie-Henderson and Co., 3 miles north of Hespeler.

In the township of Puslinch, there are two operating quarries on the main line of the Canadian Pacific railway. John Maloney operates a large quarry about half a mile west of Puslinch station. There are extensive exposures of Guelph dolomites in this neighbourhood. The stone is fairly hard, light buff, and of fine texture. Crushed stone and ground agricultural stone are produced at this quarry.

On lot 29, Front Gore, Puslinch township, Christie-Henderson and Co., Ltd., have an extensive quarry and lime kiln. The rock is similar to that of Maloney's quarry. Besides the stone for lime burning, crushed stone is produced.

On lot 15, concession V, Erin township, there are a small quarry and pot kiln operated, from time to time, by W. J. Smith. The upper beds, which are used for burning, consist of hard, light grey stone, while the lower beds, from which building stone is obtained, are buff in colour, granular, and less hard. Both are dolomite.

On lot 15, concession VI, Erin township, Ashenhurst Bros. operate a small quarry, producing rough and dressed building stone. The stone is similar to the lower beds of Smith's quarry. Sample 81 is an average of the 12 feet of dolomite exposed in this quarry.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
1............	0·30	0·14	0·06	54·60	44·80	30·69	21·43

Wentworth County.

Wentworth has long been an important stone producing district. The numerous exposures of dolomite along the top and face of the Niagara escarpment have offered splendid quarry sites. At Hamilton, a number of large quarries have been worked at the crest of the escarpment; but now, most of these have been abandoned, and only a small amount of stone for road building is being produced. At Ancaster there is a group of quarries along the face of the escarpment. Some of these are idle at present, others being operated on a greatly reduced scale. At Dundas, there is a very large quarry on the crest of the escarpment to the north of the town. This quarry, operated by the Canada Crushed Stone Corporation, Ltd., is being worked on a large scale.

On the flat highlands to the south and west of the Niagara escarpment, dolomites outcrop at a number of places throughout the county. The Wentworth Quarry Co., Ltd., operates a quarry on lot 4, concession V, Saltfleet township, near Vinemount, from which large quantities of crushed stone are produced. The Gallagher Lime and Stone Co., Ltd., and the Hamilton Lime and Cement Works, operate quarries about 2 miles south of Hamilton. Both companies produce building stone and stone for lime burning. The former company operates two draw kilns, and the latter, three draw kilns. Natural gas is used as fuel.

On lot 8, concession III, Beverly township, there are two small quarries and lime kilns, one owned by C. W. Parkes and the other by Parkes Brothers. Both were idle. On lot 6, concession VI, Flamboro W., the county operates a small quarry from

which it obtains road metal, as required. The county operates another quarry at Clappison Corners.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
82	1·00	0·28	0·32	55·32	43·47	30·99	20·79
83	0·70	0·42	0·58	53·18	43·92	29·79	21·00
84	0·70	0·27	0·13	53·18	43·92	29·79	21·00
85	5·00	0·56	0·84	52·11	41·10	29·19	19·65
86	0·50	0·30	1·10	54·25	43·92	30·39	21·00
87	1·00	0·21	0·19	53·89	43·01	30·19	20·56
88	0·60	0·34	0·06	54·25	43·01	30·39	20·56

Sample 82 is an average of the upper 8 feet of the 24-foot face in the Gallagher Lime and Stone Company's quarry on lot 15, concession VI, Barton township. The stone is a brown, rather fine-grained, granular dolomite, free from visible impurities.

Sample 83 is an average of the lower 16 feet of the same quarry. The stone is of the same character as sample 82.

Sample 84 is representative of a 4-foot bed of stone, in the above quarry. This stone, while similar to the rest in the quarry, is somewhat closer in texture, and is used for coursing stone.

Sample 85 is an average of the lower 30 feet of rock exposed in the quarry of the Canada Crushed Stone Corporation, Ltd., on lots 12 to 15, concession I, Flamboro West. This quarry is one of the largest in the country, and is very well equipped with power drills, steam shovels, locomotives and haulage systems. The crusher plant has a large capacity, delivering stone in a number of grades. The upper 40 feet of the stone in the quarry is used for flux. An analysis of this, quoted by Parks,[1] shows it to be an exceptionally pure dolomite. The lower 30 feet produces stone used largely for concrete and road work.

Sample 86 is an average of the 10-foot face in the County quarry, lot 6, concession VI, Flamboro West. The stone is a fine textured, granular, rather porous dolomite.

Sample 87 is an average of the hard, light-bluish dolomite from Parkes Bros.' quarry on lot 8, concession III, Beverly township.

Sample 88 is an average of the upper 18 feet of stone exposed in Guest's quarry on lot 48, concession II, Ancaster. The quarry is worked in two steps. The upper 18 feet, used principally for lime burning, is a pure, medium fine-grained, brown dolomite, and the lower 15 feet, which is less pure, is used for the production of crushed stone for roads and concrete.

Lincoln County.

Along the Niagara escarpment and the side ravines leading from it, there are numerous good quarry sites. Many small quarries and three large ones have been opened.

On lots 14 and 15, concession VI, Clinton township, are the extensive quarries of the late Hon. Wm. Gibson, of Beamsville. Great quantities of heavy dimension stone have been obtained from these quarries, which have been idle for several years. The stone is a medium-grained, porous, light buff dolomite, containing a little over 3 per cent total impurities.

On lot 1, concession VII, Clinton township, Jacob Fritz operates a very small quarry in similar stone to that of the Gibson quarry. A number of small quarries

[1] Page 252, Mines Branch Report No. 100.

are operated, from time to time, at various points in Louth township. A. F. Rubel has a small quarry on lot 20, concession VI, Louth, and also burns lime in two pot kilns. The stone is a dolomite, similar to that of the Gibson quarry, but occurs in thin beds.

There is a series of small quarries on lots 15, 16, and 17, concession X, Grantham township. There are two types of stone exposed. The upper stone is a brownish-grey, medium fine-grained, dolomite, of irregular bedding and jointing, and containing some flint. The lower stone is a fine-grained, blue-grey magnesian limestone, in heavy beds.

In Niagara township there are two large quarries owned by the Queenston Quarry Co., Ltd., and the Standard Crushed Stone Co., Ltd.

The quarry of the Queenston Quarry Company is situated on lots 47, 48, and 49, Niagara township. The stone in the upper 18 feet of the quarry is a medium-grained, grey dolomite, and in the lower 15 feet is fine-grained, blue magnesian limestone. The product of the quarry consists of various grades of building stone and crushed stone. As the beds are thick and free from undesirable jointing, large blocks of stone are easily procurable.

The quarry of the Standard Crushed Stone Company is on adjoining lots and is opened in the same beds of stone. This quarry, which has a large output, produces crushed stone and rubble.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
69	1·70	0·80	0·20	56·39	39·16	31·59	18·72
60	2·50	0·90	0·10	78·88	15·91	44·19	7·61
81	8·50	0·60	1·20	64·94	23·93	36·39	11·44
92	8·80	0·84	0·56	51·04	37·27	28·60	17·81

Sample 89 is an average of the upper 18 feet of grey dolomite from the quarry of the Queenston Quarry Company.

Sample 90 is an average of the lower 15 feet of blue magnesian limestone from the same quarry as sample 89.

Sample 91 is representative of the lower blue magnesian limestone beds in H. C. Ball's quarry, lot 15, concession X, Grantham township.

Sample 92 is an average of the face of Peter Belton's quarry, lot 17, concession X, Grantham township. It also represents the stone in the upper part of Ball's quarry.

Welland County.

Along the escarpment to the east of the canal, near Thorold, there are several large quarries in the Niagara formation, which have been worked for many years. At present, the only operating quarry is that of Walker Brothers, on lots 31 and 32, Stamford township. In this quarry the upper 20 feet of stone is a porous, fine-grained, brown dolomite, and the lower 10 feet is a close-grained, coarse, light blue dolomitic limestone.

Along the Lake Erie shore, the clay overburden, which covers the greater part of the county, is comparatively light, and a number of quarries have been opened in the underlying Onondaga limestone.

On lot 6, concession I, Wainfleet township, there are a number of quarry openings, one of which, lying to the north of the railroad, has been worked up to two years ago. As the pits were almost full of water, no satisfactory samples could be obtained. From pieces of stone found near the quarry, and from those beds above water level,

it would appear that the stone was a dark grey, medium fine textured, high calcium limestone. Some beds contained considerable chert. Lime was produced in a gas-fired draw kiln. There is also a crusher plant in connexion with the quarry.

On the adjoining lot to the east, Pilkington Brothers, Limited, at one time operated a quarry from which they obtained limestone for glass making.

Immediately west of Port Colborne, the Canada Cement Company, Limited, operates large quarries which supply limestone for use in the manufacture of portland cement. Analyses of the stone from these quarries, furnished me by the Canada Cement Company, show it to be 7 per cent silica, 48 per cent lime, and 2¼ per cent magnesia.

A large quarry has been worked on lots 3, 4, 5, and 6, concession I, Humberstone, by the Empire Limestone Company. There is an extensive crushing plant at the quarry. At the time it was visited, the quarry was idle and contained much water. No sample of the stone was taken.

Two quarries of the Standard Crushed Stone Company, Limited, are situated on lot 13, Lake Erie front, Bertie township. One of these covers about an acre and one-half, and has been excavated to a depth of 22 feet. The upper beds of this quarry are made up almost entirely of flint, and the lower beds are blue limestone carrying much flint. A new quarry was being opened in beds apparently of a lower horizon. The stone is light bluish-grey, of coarse texture, and in beds up to 2 feet thick. The old quarry is well equipped, and produces several sizes of crushed stone.

The Coast and Lake Construction Corporation owns a large quarry, which is now idle, on lot 14, Lake Erie Front, Bertie township. This quarry is well equipped for producing dimension stone as well as crushed stone. The rock is similar to that in the quarries of the Standard Crushed Stone Co.

On lot 4, concession VIII, Bertie township, there is an old quarry and lime kiln owned by E. and B. Baxter. The stone exposed is similar to what is seen in the foregoing quarries.

The Bertie township quarry is situated on lot 7, concession VIII. About 20 feet of strata is exposed here. There is much flint in the upper beds of high calcium limestone. The lower beds are of dolomite. The equipment consists of steam drills and a small crusher plant.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
93	1·60	0·71	0·49	57·45	40·00	32·19	19·13
94	2·00	0·55	0·45	68·87	26·51	38·59	12·69
95	3·50	0·42	1·38	94·22	0·52	52·89	0·25
96	6·80	0·71	0·89	50·68	39·46	28·39	18·86

Samples 93 and 94 were taken in Walker Bros'. quarry, near Thorold. Sample 93 is an average of the upper 20 feet, and sample 94, of the lower 10 feet.

Sample 95 is a representative of the stone exposed in the new quarry of the Standard Crushed Stone Co., Ltd., on lot 13, Lake Erie Front, Bertie township.

Sample 96 is an average of the lower 14 feet of stone exposed in the Township quarry, lot 7, concession VIII, Bertie township.

Haldimand County.

Over the greater part of this county the rocks are masked by overburden. There are, however, a number of localities where there are outcrops and where quarrying has been done.

At Byng, near Dunnville, John Webber operates a quarry from which he produces building and crushed stone. About 22 feet of strata is exposed. The upper 10 feet is a thinly bedded, light grey, tough dolomite, and the lower 12 feet is a bluish, fine-grained dolomite, in beds from 6 inches to 18 inches thick.

About half a mile east of Webber's quarry there is another, which, I understand, belongs to the county. The stone is similar to the foregoing. There is a small crushing plant alongside the quarry. It is worked as occasion requires.

The Oneida Lime Co., Ltd., owns quarry land 1 mile north of Nelles Corners. Quarries have been opened in Oriskany sandstone and in the underlying dolomite. At present, operations are confined to the sandstone quarries. Large quantities of very fine sandstone are quarried and crushed for the production of sand for glass manufacturing and for other purposes requiring a highly siliceous sand. The dolomite is fine-grained, buff, and occurs in thin beds. A considerable quantity has been quarried for flux and lime burning.

On lot 49, concession I, South Cayuga township, about one mile south of the above, the county operates a quarry in the high calcium limestone of the Onondaga formation. The quarry was full of water at the time of my visit; but, from broken stone at the crusher plant it would appear that the stone is similar to that in the Port Colborne quarries, and carries considerable flint.

On lot 2, concession II, Rainham township, Fred Helka operated a lime kiln and quarry up to 1916. There is a considerable area on this farm where the overburden is very light, and a number of shallow openings have been made, from which building stone and stone to supply the kiln were obtained. There is about 8 feet of strata exposed. The upper 4 feet is thin bedded, fine-grained, rather dark brownish-grey limestone, containing a small amount of flint. The lower 4 feet is more heavily bedded, and free from flint, but has a small quantity of shale between the beds.

In the immediate neighbourhood of Hagersville there are one small and three large quarries, only one of which was in operation in September.

The Hagersville Contracting Co., Ltd. (idle), the Hagersville Crushed Stone Co. (idle), and the Michigan Central Railway Co., all have large, well equipped quarries and crusher plants. The Hagersville Stone Co., Ltd., owns a quarry site, and has opened a small quarry, but has deferred further development. The stone in all these quarries is alike, being a close-grained, hard limestone, some beds of which are very cherty.

There is an abandoned quarry on lot 6, concession XIV, Walpole township, belonging to A. S. Wieger. The stone is different from any observed in the other quarries of the district, being a very light yellow dolomite, fine in texture, and lying in thin beds. There is evidence of slight faulting and bending.

Two miles to the west of this is another small quarry on lot 1, concession XIV, owned by W. A. Teitz. At one time lime was burned here, but in recent years only building stone for local use has been quarried. The stone, which is made up largely of coral fragments, is a light bluish-grey, high calcium limestone. The heaviest bed exposed is about 10 inches thick.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
97	11·50	0·70	2·30	48·90	36·20	27·40	17·31
98	8·60	0·56	0·64	51·75	38·10	28·99	18·21
99	2·00	0·42	0·38	55·32	40·14	30·99	19·19
100	4·30	0·45	0·35	92·80	1·51	51·99	0·72
101	1·20	0·32	0·28	53·88	42·42	30·18	20·29
102	6·40	0·36	1·04	89·94	1·21	50·39	0·58

Samples 97 and 98 are from Webber's quarry in Byng. Sample 97 is an average of the upper 10 feet, and 98 an average of the lower 12 feet.

Sample 99 is representative of the dolomite in the quarry of the Oneida Lime Company, on lot 49, concession II N. Cayuga township.

Sample 100 is an average of the strata exposed in Helka's quarry, lot 2, concession II, Rainham township.

Sample 101 is representative of the stone in the old quarry owned by A. S. Wieger, lot 6, concession XIV, Walpole township.

Sample 102 is an average of the strata exposed in Teitz's quarry, lot 1, concession XIV, Walpole township.

Norfolk County.

Along the shores of Long Point bay of Lake Erie, limestone outcrops at frequent intervals, but good quarry sites are rare. A small quarry has been worked on lot 24, concession I, Woodhouse township, by Geo. Howey. Fourteen feet of strata is exposed in the quarry, which has been opened along a small brook issuing from a cave in the limestone. The upper 8 feet is fine-grained, bluish to brownish-grey. The lower 6 feet, while similar to the above, contains much flint. Sample 103 is an average of the upper 8 feet.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
103...........	4·30	0·22	0·18	89·23	4·54	49·99	2·17

Small quarries have been worked at several points along the road between concessions VIII and IX of Townsend township. The stone is similar to what is seen at Tietz's quarry, lot 1, concession XIV, Walpole township, Haldimand county.

Waterloo County.

The only rock outcrops observed in Waterloo county were at Galt and Hespeler At Galt there are old abandoned quarries along the Grand river above the town, as well as one owned by Jas. Webster, which is operated from time to time. A quarry and two lime kilns, belonging to Christie-Henderson and Co., Ltd., are situated on the southern outskirts of Galt, to the east of the river. The stone at all these quarries is very light buff to bluish-grey dolomite, mostly heavily bedded. It is similar to the stone at the Elora quarries and belongs to the same formation. Sample 104, taken in the Christie-Henderson quarry, shows it to be a very pure dolomite.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
104...........	0·20	0·28	0·12	56·55	42·56	31·68	20·35

An old, abandoned quarry belonging to Christie-Henderson and Co., Ltd., is situated to the west of Hespeler, on the flats of the river valley. The stone, which is a light yellow, Guelph dolomite, similar to that at the same company's quarry to the north of Hespeler, in Wellington county, has been quarried, to a depth of 6 feet, over about two acres.

Oxford County.

Along the Thames river, between Woodstock and Ingersoll, there are several quarries in a very pure, high calcium limestone. The Beachville White Lime Co., Ltd., operates a large and well equipped quarry about 2 miles southwest of Beachville. About two acres have been quarried to a depth of 27 feet, and another lift of 10 feet is now being taken. The stone is a light bluish to brown, fine-grained, compact to rather porous, granular limestone. The beds are up to 2 feet in thickness; but are not used for building stone. The stone is used for lime burning, flux for iron and steel making, cynamid and sugar manufacturing. The company operates two large wood-fired draw kilns.

The Standard White Lime Co., Ltd., operates quarries about 1 mile east of the above quarry. The quarries have been worked to a maximum depth of 30 feet, and cover about seven acres. The stone is, apparently, identical with that of the former company. Sample 105 is an average of the 30-foot face of the western pit.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
105...........	0·70	0·21	0·19	96·37	2·27	53·99	1·09

The quarries are fully equipped to handle a large output. Five coal fired draw kilns are operated by this company.

On lot 8, concession XVII, East Zorra, there are an old quarry and two draw kilns, belonging to the Callan Estate. The stone is a light yellow dolomite, of fine to medium grain. No satisfactory sample could be taken, as there was much water in the quarry, and the sides were filled in. It has been idle for two years.

Perth County.

Quarrying in this county is limited to the immediate neighbourhood of St. Marys. The Standard White Lime Co., Ltd., operates a quarry and twc draw kilns near the Grand Trunk Railway on the north side of St. Marys. A 20-foot face has been developed in a fine-grained limestone. The rock is a light buff, banded with brown, probably due to bituminous matter. Most of the beds are thin, though some are heavy. There is about 10 feet of overburden at the west end of the quarry.

The Thames Quarry Co., Ltd., operated until recently a large quarry on Water street, beside the Thames river. The crusher plant was destroyed by fire. As a result the quarry was shut down and soon filled with water, so that I was unable to examine the stone.

To the south of St. Marys, just outside the town, is situated the plant and quarry of the St. Marys Cement Co. Thirty-five feet of strata is exposed. The stone is a hard, fine-grained, very compact, brownish limestone, in heavy beds with some shale partings.

The quarry of the Horseshoe Quarry Co., is situated on the adjoining lot to the east. The same beds are being worked. This quarry covers about three acres. It is well equipped with quarry machinery and crusher plant. There is also one draw kiln, but it is not being operated at present.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
106	1·90	0·45	0·55	94·22	3·00	52·79	1·43
107	3·40	0·28	0·32	93·87	1·51	52·59	0·72

Sample 106 is an average of the face in the Standard White Lime Co's quarry, St. Marys.

Sample 107 is an average of the face in the St. Marys Cement Co's quarry.

Essex County.

The only quarry visited in this county was that of the Solvay Process Co., a mile northeast of Amherstburg. About 50 feet of strata is exposed in this quarry. In the upper or old portion of the quarry, the rock has been worked to a depth of about 30 feet. The stone is a very light buff, fine-grained dolomite, in heavy beds. It was worked extensively for building stone. The new quarry has been sunk to a depth of about 20 feet in the floor of the old workings. The lower beds are extremely fine-grained, very light bluish-grey, high calcium limestone. Sample 108 is an average of the stone in the lower workings.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
108	1·60	0·42	0·38	97·08	0·56	54·40	0·26

Huron County.

There are few exposures of limestone in Huron county, and those, so far as were observed, offered very poor sites for extensive quarrying.

The exposures are along the shore of Lake Huron and on the steep banks of some of the rivers. In practically all cases, quarrying operations would very soon be hampered by a heavy overburden. No quarries were being operated, but several old workings were visited. At the base of the steep banks of the Maitland river, near Goderich, there are exposures of a few feet of strata made up of rather impure dolomites and magnesium limestones.

Along the Harriston river, in Howick township, there are exposures of thinly bedded, hard, fine-grained, banded dolomite, in which several small quarries have been worked to supply foundation stone and lime for local use.

Sample 109 is an average of the 12-foot face of an abandoned quarry on lot 13, concession VIII, Howick township.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
109	3·70	0·14	0·06	52·47	41·68	29·39	19·93

Bruce County.

There are numerous exposures of high grade limestone and dolomite in Bruce, especially in the northern and eastern parts of the county. In Kinloss township, where rock exposures are rare, many farmers have small pot kilns, in which they produce lime from boulders gathered from the fields and stream beds. These boulders are usually of high calcium limestone.

At Inverhuron, 9 miles north of Kincardine, John S. Smith operates a pot kiln, producing a good grade of lime from loose stone gathered on the shore of lake Huron. Near his kiln is an old quarry in heavily bedded, light buff dolomite.

To the southeast of Kincardine, on lots 6 and 7, concession III S., Kincardine township, A. W. Holland burns lime from stone obtained from a small quarry in the valley of the Penetangore river. The rock is a brown, medium-grained, highly magnesian limestone, and occurs mostly in thin beds; though some are up to 2 feet in thickness, and have furnished stone for bridge work and building purposes.

At the end of September, the Toronto Plaster Co., Ltd., put into operation their new lime plant at Teeswater. The plant consists of a battery of three draw kilns, and Clyde hydrating equipment. A quarry had recently been opened near the lime kilns, in a light buff, rather soft, porous dolomite. It had only been sunk to a depth of 6 feet in the rock at that time.

The Contractor's Supply Co., Ltd., owns a quarry, near that of the Toronto Plaster Company, from which stone was obtained to supply their lime and hydrator plant at Melville Junction. The stone in both quarries appears to be the same.

The Teeswater Lime Works is situated on the opposite side of the town beside the river. The quarry has a face about 135 feet long and 30 feet high. The stone is similar to that described above with the exception of two thin beds of banded stone which are not used for lime, as they burn to a dark colour. The company operates one small draw kiln. About 5 miles east of Teeswater, there are an old quarry and lime kiln on lot 8, concession A, Carrick township. The stone is a light blue, brecciated limestone.

Similar stone is exposed at a number of places along the road separating the townships of Culross and Carrick, and numerous small quarries have been worked in the past.

Outcrops of limestone were examined at several points along the Saugeen river. Wherever exposed the stone proved to be a very fine-grained, light buff dolomite. This stone has repeatedly been referred to as of lithographic grade. It can hardly be classed as such, since it is not of sufficient fineness nor uniform enough in texture to satisfy the requirements of modern lithography.

A small quarry and lime kiln, owned by Wm. Reed, is situated on lot 2, concession VII, Brant township, in the valley of a small stream that flows into the Saugeen river at the Ox Bow. The stone is very fine-grained, light buff dolomite, occurring in beds of varying thickness up to almost 4 feet. Both the stone and the lime find a limited local market.

John S. Cook produces building stone, flags and monument bases from quarries on lot 7, concession XXIV, Amabel township. The stone, which is a rather dark brown, granular dolomite, occurs in beds from a few inches to 2 feet thick. The jointing is regular, and widely spaced, permitting blocks of large area to be lifted. The quarries cover several acres, and have been worked to a depth of 6 feet. Since the beginning of the war the quarries have not been worked steadily.

Two pot kilns owned by Sam Vogan are situated on Gould street, Wiarton. They are used from time to time to produce lime from fieldstone gathered on nearby farms. The stone is a very light yellow, hard, compact dolomite. Exposures of similar stone are seen on the roadside on Gould street and in the face of the escarpment which skirts the west shore of Colpoy bay.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
110	1·50	0·28	1·12	57·46	39·05	32·19	18·77
111	0·60	0·30	0·90	64·28	32·42	36·01	15·50
112	0·20	0·28	0·92	55·32	42·22	30·99	20·19
113	0·70	0·21	0·19	97·08	1·96	54·39	0·94
114	2·20	0·21	0·19	53·54	42·86	29·99	20·49
115	0·35	0·18	0·16	55·99	43·71	31·39	20·95

Sample 110 is representative of the dolomite in an old quarry at Inverhuron, owned by John S. Smith.

Sample 111 is an average in Holland's quarry on lots 6 and 7, concession III S. Kincardine township.

Sample 112 is an average of the stone exposed in the quarry of the Toronto Plaster Company, Limited, at Teeswater. As the stone in this newly opened quarry shows evidence of surface decomposition, it is probable that the more solid rock, when reached, will show a somewhat different composition.

Sample 113 is an average of the brecciated limestone on lot 8, concession A, Carrick township.

Sample 114 is representative of the stone used for lime burning by Wm. Reed, lot 2, concession VII, Brant township.

Sample 115 was taken from an exposure on Gould street, Wiarton.

Grey County.

The town of Owen Sound is encircled on three sides by cliffs of dolomite which extend along the shores of the deep inlet of Owen Sound. Excellent quarry sites exist both along the face of the escarpment and on the level highland above. At present quarrying is limited to four properties.

Chalmers and Campbell are operating the quarry owned by the Chalmers Estate. This quarry is situated at the crest of the escarpment to the southwest of the town. The stone is a hard, close-grained dolomite, varying in colour from light bluish to yellowish-grey. The workings are about 150 feet square, and have a face 15 feet high. The stone is used entirely for lime burning in two large draw kilns.

One-third of a mile north of Chalmers', is the quarry and lime plant of the Oliver Brown Estate. There is one draw kiln, but this was idle in 1917. The quarry and a small crusher plant were being operated by the Corporation of Owen Sound for the production of crushed stone for road work. The stone is similar to that exposed in the Chalmers quarry.

Geo. A. Perkins produces cut stone from a quarry on the top of the cuesta immediately above the Brown quarry. His quarry is only operated as stone is required, from time to time. The beds are heavy, and produce blocks of good size, and pleasing colour.

On the highland to the east of Owen Sound there is a group of quarries from which rough building stone and crushed rock are produced. In October, only one quarry was found in operation, that of the Oliver Rogers Stone Co., Ltd. This quarry is about 700 feet by 200 feet, with a 12-foot face. The stone is a dark grey, fine-grained, hard, and very tough dolomite. The quarry is equipped with steam drills, steam shovel, derricks, hoists, and a crusher plant.

Other quarries in the immediate neighbourhood are owned by the H. B. Harrison Estate, Chas. Hazelton and Davis-Smith-Malone.

To the south of Owen Sound and along the Toronto and Sydenham road, as far as Markdale, there are numerous exposures of dolomite similar to that on the west hill at Owen Sound. At a number of points quarrying has been done and lime burned, but only on a very limited scale.

On lot 25, concession IX, Artemesia township, J. H. Duckett operates two small pot kilns, producing a good grade of white lime for local trade from fieldstone. On the same lot there is an exposure of dolomite similar to the dolomite at Eugenia falls, described below. Throughout the southern part of the county there are many of these small kilns operating on fieldstone.

At Eugenia the Beaver river falls over a high escarpment into a deep gorge. The upper beds exposed in this escarpment consist of a very hard, light buff dolomite, very much like that in the quarries to the west of Owen Sound.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
116	0·50	0·15	0·05	54·60	44·60	30·59	21·32
117	6·40	1·40	0·20	51·59	40·34	28·90	19·30
118	0·45	0·27	0·23	55·25	43·90	30·95	21·05

Sample 116 is an average from the quarry owned by the Chalmers Estate, to the west of Owen Sound.

Sample 117 is an average of the face in the Oliver Rogers Stone Co's quarry on the hill to the east of Owen Sound.

Sample 118 is representative of the upper 20 feet of strata exposed at the Eugenia falls on the Beaver river.

Dufferin County.

About 1½ miles east of Shelburne there is a quarry, owned by W. C. Hall, on lot 32, concession I, Amaranth township. The stone, which is used for building purposes only, is a light buff, fine, granular textured dolomite, occurring in beds up to 3 feet thick. It is of good cutting quality, though some beds are flawed by cavities.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
119	0·50	0·14	0·06	55·32	43·92	30·99	21·00

Sample 119 is an average of the stone in this quarry.

To the south of Shelburne, no outcrops of limestone were observed until Orangeville was reached. To the east of that town, on lot 1, concession I E., Mono township, there are a small quarry and two pot kilns which are used at odd times. The stone exposed in this small quarry is a light yellowish, hard, compact dolomite, similar to that in the quarry of the Contractor's Supply Co., near Melville Junction.

Simcoe County.

On lot 47, concession XI, Nottawasaga township, there is an old quarry known as the Cramp Steel Co. quarry. About 5 feet of very fine-grained, dark grey limestone is exposed in the old workings. This stone has been mentioned in several

reports as being a lithographic stone. It is hardly fine enough, and is certainly not regular enough in texture for lithographic purposes.

W. D. Chestnut operates a large pot kiln on lot 25, concession XI, Nottawasaga township. Stone is obtained from a number of openings along the face of a steep escarpment. It is a very pure, light buff dolomite, similar to that on the west hill at Owen Sound.

A large quarry, once operated by the Canada Iron Corporation, but which is now idle, is situated on lots 19 and 20, concession V, Tay township, near the shore of Gloucester bay. It has been worked to a depth of about 15 feet over an area of five acres. The upper beds are light brownish-grey, fine-grained magnesian limestone, and the lower are dark brown and of very fine texture.

The Peters Coal Co. operates a quarry and crusher plant on lot 20, concession XIII, Medonte township. The upper 25 feet of stone in the quarry is very fine-grained, cream to dark brown, and is hard and brittle. The lower 6 feet of strata is medium fine-grained, granular magnesian limestone. Both are in heavy beds.

Sedden and Murphy, at one time operated a quarry on lot 21, concession XIV, Medonte township, in stone similar to that in the base of the Peters' quarry. Judging from blocks lying in the quarry, this stone does not possess good weathering qualities.

On lot 15, concession II, North Orillia township, there is a small quarry owned by Geo. A. Abbott. The upper beds are dark buff dolomite, and the lower beds light grey, impure magnesian limestone. On the west end of the same lot, there is an exposure of a very fine-grained, high calcium limestone.

The Ontario Stone Corporation, Ltd., operates a large quarry on lot 10, concession IV, North Orillia. The stone is a hard, brittle, fine-grained limestone. Much of it is of extreme fineness, but contains too many flaws for lithographic use. The quarry is well equipped and a large crusher plant and storage system have recently been installed.

On lot 12, concession VII, North Orillia, Martin Glabb operated a small pot kiln up to 1916. Stone was obtained from a ridge of limestone which crosses this lot. It is similar to that in the quarry of the Ontario Stone Corporation.

Throughout the county there are a number of small pot kilns, which are used at rare intervals, operating principally on fieldstone.

Sample Number.	Insoluble Mineral Matter.	Ferric Oxide.	Alumina.	Calcium Carbonate. *	Magnesium Carbonate. †	* Equivalent to Lime.	† Equivalent to Magnesia.
120	11·00	1·12	1·08	82·90	3·79	46·45	1·81
121	0·50	0·56	0·04	53·89	43·95	30·19	21·02
122	4·70	0·98	0·22	60·32	33·62	33·80	16·08
123	6·70	1·12	0·08	71·02	21·13	39·79	10·10
124	5·60	0·14	0·06	89·59	4·24	50·20	2·03
125	6·30	0·97	0·23	61·03	30·30	34·19	14·49
126	3·19	0·25	0·13	94·20	1·88	52·76	0·90

Sample 120 is representative of the stone in the old Cramp Steel Co's quarry, near Collingwood.

Sample 121 is an average of the stone exposed in the quarry of W. D. Chestnut, on lot 25, concession XI, Nottawasaga township.

Sample 122 is an average of the upper 5 feet of stone in the Canada Iron Corporation quarry, lots 19 and 20, concession V, Tay township.

Sample 123 is an average of the lower 8 feet of the same quarry.

Sample 124 is an average of the upper 25 feet of the Peters Coal Co. quarry on lot 20, concession XIII, Medonte township.

Sample 125 is an average of the lower 6 feet of the same quarry.

Sample 126 is an average of the stone in the quarry of the Ontario Stone Corporation, Ltd., on lot 10, concession IV, North Orillia township.

MANUFACTURE OF WHITING FROM MARL.

Some 25 or 30 years ago the late W. G. Allan of Marlbank, Hastings county, manufactured whiting by pumping marl from a lake, through screens, into settling tanks. After air drying in sheds, it was sometimes further dried by artificial means. The whiting is said to have been of good quality.

A sample of marl was collected from Dry Lake, near Marlbank, along a ditch dredged by the Canada Cement Company. A rough laboratory separation of 300 grams, without previous grinding, was made with a small hydraulic classifier, which gave the following products:—

Fine Whiting.........	105·3 grms.	35·1%	Very light cream.
Coarse Whiting......	131·7 grms.	43·9%	Very light cream.
Fine Middles........	5·2 grms.	1·8%	Dark cream.
Coarse Middles......	18·1 grms.	6·0%	Dark cream.
Tailings.............	27·3 grms.	9·1%	Grey.
Loss.................	12·4 grms.	4·1%	

The first two products are of a fineness suitable for commercial use, while the middles would have to be subjected to grinding to prepare them for the market. Owing to impurities, such as sand and vegetable matter, the tailings could not be made use of for whiting, but should readily find a market in place of ground limestone for soil correction.

There are a great many lakes throughout Ontario, in which there are large deposits of marl of suitable fineness for the production of whiting. While the majority of these marls dry to a light cream colour, there are doubtless some from which an almost pure white product could be obtained. Since the beginning of the war, the market price of whiting, as quoted to paint manufacturers, has increased to about three times the pre-war price. As the apparatus necessary for the washing of whiting from marl need not be complicated, the capital required would not be great, and it is altogether likely a profitable industry could promptly be developed.

II

THE CANADIAN GRAPHITE INDUSTRY.

Hugh S. Spence.

With the object of collecting data for a new edition of the Mines Branch report on graphite, published in 1907, and which has been out of print for several years, the writer visited the graphite mines and mills in the Provinces of Ontario and Quebec. The graphite occurrences in these Provinces constitute the source of supply of all the graphite that has been produced in Canada in recent years. All the properties lie within a radius of 150 miles of Ottawa.

An attempt to exploit graphitic shales near St. John, N.B., was made many years ago, and a production was reported from that locality by the Canada Paint Co., as late as 1896. These shales carry a very finely-divided, amorphous graphite: a grade which is only suitable for pencil making, paints, or foundry work. Similar graphitic shales are known, also, from various other places in New Brunswick, as well as from Nova Scotia.

In British Columbia, disseminated graphite is reported to occur at Alkow harbour, Dean channel, and near Harrison lake. A vein of amorphous graphite near Marysville, Cranbrook district, was examined by the writer in 1916, and was reported on in the Mines Branch Summary Report for that year. None of these graphite occurrences have been exploited to any extent, though a small trial shipment is reported to have been made from the Harrison lake property; and a shallow prospect pit has been put down on the Marysville vein. The latter is only 18 inches wide, and consists of a mixture of silicates and amorphous graphite, the carbon content being about 25 per cent.

The shortage of graphite experienced in the United States during the last three years has been caused by the greatly increased consumption in the crucible manufacturing industry; shipments of Ceylon graphite—which is the grade preferred for this work—being insufficient to supply the trade. The demand for flake graphite has resulted in a great increase in mining activity in the United States, and a brisk demand has been experienced for Canadian flake. In spite of this, however, the adverse conditions which have long hampered the graphite industry in this country still persist, and during 1917 only three companies operated at all steadily, there being nine mines, each equipped with a mill, that have been either completely idle or in only intermittent operation. Various causes have conduced to this state of affairs, among them being: (1) failure to devise a proper concentration process for the particular ore to be treated; (2) erection of mill without sufficient care being taken to establish the existence of an adequate ore-body, which sometimes resulted in ore having to be hauled to the mill from outlying pits; and (3) remote situation of the property, necessitating an expensive road-haul for fuel and supplies. In several instances, large expense was incurred in the erection of a mill out of all proportion to the size of the ore-body—as subsequently developed. The power-consumption alone, in such a mill, using as fuel, wood or coal, which has to be brought a considerable distance, is a factor that has conduced to the lack of success attending operations at certain of the properties. In this connexion, it may be noted that of the two active mills running on disseminated flake graphite ore, one is using oil as fuel, and the other is operated by water-power.

The flake graphite occurs in disseminated form either in crystalline limestone (Haliburton and Hastings counties, Ontario) or in more or less calcareous bands intercalated in gneiss (Buckingham district, Quebec), the latter ore as a rule carrying more graphite (10-15 per cent) than the limestone, which averages 7-10 per cent. Both varieties of ore carry flake mica, pyrite, pyrrhotite, and lime silicates, as the principal accessory minerals; and both have been treated by essentially similar concentration methods. These are, briefly, drying in wood-fired kilns; reducing in gyratory crushers followed by two or more sets of heavy rolls; and subsequent alternate screening and crushing in rolls of the flour-mill type. Each set of rolls eliminates gangue by reducing the brittle calcite and silicates to powder, while the soft graphite tends to flatten out and is caught by the screens. The produce from the final set of rolls is sometimes polished between buhr-stones, or goes to an electrostatic machine, which removes any remaining impurities, particularly mica; the latter is one of the most difficult minerals to get rid of, owing to its softness, and consequent resistance to crushing. In the early days of the graphite industry, a wet process of concentration, employing buddles, was practised. This method is still in use at one mill, as the initial step in concentration, followed by drying; the dried product then proceeding to rolls, screens, and buhr-stones.

One of the most recently constructed mills practises wet concentration by means of tables and hydraulic classifiers, followed by drying in a vacuum filter and kiln, and polishing between rolls. Good results are obtained in some mills, also, by the use of dry tables.

Concentration by means of water flotation, such as is in general practice in the mills of Alabama, U.S.A., is not employed at any mill in Canada.

While certain of the mills achieve a fair recovery of the graphite contained in the ore treated, the majority lose an undue percentage in the tailings. The concentration methods in general use are far from being efficient. In addition to poor recovery, the carbon content of the best, or No. 1 product, is seldom brought over 90 per cent, and is generally lower; a great deal of the flake in the rock is broken up in the milling, and goes into the smaller mesh No. 2 product, and to the No. 3 or dust; while the large amount of dust produced in the mill in grinding the kiln-dried ore is very objectionable. Screen tests on samples of No. 1 flake from seven mills, showed the mean percentages of different size flake composing this grade to be as follows:—

+ 20 mesh..	1·76 per cent.	+100 mesh..	1·10 per cent.
+ 40 "	18·56 "	—100 "	2·96 "
+ 60 "	67·00 "		
+ 80 "	8·06 "		99·34 "

Most mills produce three grades of graphite, known as No. 1 flake; No. 2 flake; and dust. The No. 1 flake goes principally to the crucible trade; No. 2 is employed in lubricating products; and No. 3, or dust, is used in foundry work.

The graphite particles employed in crucible manufacture are required to be of a certain size, in order to bind efficiently with the clay. In this connexion it may be noted, that one of the reasons for the preference for Ceylon graphite for use in the manufacture of crucibles is, that this variety does not occur in thin flakes like the American graphite, but is more massively crystalline, and breaks up on crushing into more angular fragments, hence requires less clay as a binder.

III

INVESTIGATION OF CERTAIN SAND AND SANDSTONE DEPOSITS.

L. Heber Cole.

On the 10th of May, 1917, I proceeded to the Maritime Provinces to make a special investigation of the sandstones of eastern Canada, with a view to determining their suitability for use as pulpstones. The field work in connexion with this investigation was completed by the middle of June, and laboratory tests were made on the samples obtained, and the final report handed in for publication on the 20th of August. The results obtained from this investigation have been published as a separate Bulletin, No. 19, entitled "Test of some Canadian sandstones, to determine their suitability as pulpstones." The remainder of the field season was devoted to an examination of the sand and sandstone deposits of the Province of Ontario, between Ottawa and Toronto, special attention being given to the sands suitable for foundry purposes, and deposits high in silica. Three weeks were also spent examining the Potsdam sandstone area in the Province of Quebec, southwest and west of the Island of Montreal. An examination was also made of the occurrence of Oriskany sandstone in the vicinity of Cayuga, Ont. Numerous samples from the more promising localities were obtained; and these are being analysed and tested in the Mines Branch laboratories.

Until the analyses of the samples taken are completed, and the laboratory tests made, no definite statements can be given with regard to the purity of the silica samples obtained. The following brief descriptions of rocks will, however, give an idea of the sources from which silica may be obtained.

Potsdam Sandstone in southwestern Quebec.—The Potsdam sandstone which is so largely developed near the New York border, between Huntingdon and Hemmingford, as well as along the St. Lawrence and Ottawa rivers, is in many places fairly free from iron oxide. The grains of the rock are small, and, in most cases, the material crushes readily. The best exposures with reference to transportation are to be found in the vicinity of Beauharnois, Melocheville, Cascades Point, and in the area lying between the St. Lawrence river and Lake of Two Mountains. North of the Ottawa river, a number of outcrops are conveniently situated with reference to the several different railways, notably those at St. Canute and St. Scholastique. Material from these deposits has been employed in Montreal and elsewhere for the manufacture of bottle-glass; for steel foundry work; and for furnace linings. A number of samples were obtained from this area.

Brockville Area.—In the vicinity of Brockville a number of deposits of Potsdam sandstone, as well as quartzites, occur, which on examination in the field seemed promising as possible sources of silica. Samples of these were procured, and are being tested. The sandstone from this locality is compact and fine-grained.

Westport Area.—In the vicinity of Westport and Newboro in the townships of Crosby, North and South, there is an extensive exposure of fine-grained sandstone. In many places this sandstone is badly stained with iron oxide, but a number of outcrops were noted and sampled, in which certain beds were comparatively free from impurities. The material crushes readily to the natural grain of the sand, which is between the 16 and the 100 mesh.

Perth-Smiths Falls Area.—In the vicinity of Perth, and between Perth and Smiths Falls, another sandstone area was visited. The iron-stained beds noted in the Westport area are also to be found in this area and the white beds are not so numerous or so thick.

Nepean Area.—About 9 or 10 miles to the west of Ottawa, a number of quarries have been operated for a considerable time producing building stone and paving-bricks. The waste material from these quarries will average about 95 per cent silica; and in certain beds a white rock can be obtained which crushes readily into sizes suitable for the manufacture of glass.

Kingston Area.—In the vicinity lying between Kingston and Gananoque on the St. Lawrence river and running northwest to Sydenham, there are numerous outcrops of Potsdam sandstone, which were examined; and in a number of cases were found to be fairly white, and uniformly free from iron stains. In several of the outcrops sampled, the white beds were of considerable thickness, and could be readily quarried without having an excessive amount of waste material.

The Oriskany Sandstone Area.—In the vicinity of Cayuga there is a narrow belt of Oriskany sandstone running northwest, which at one place (Nelles Corners), is already being quarried and manufactured into a glass, and steel foundry sand. The material carries a small quantity of brown colouring material (presumably organic matter) which burns out in the furnace. A number of samples were taken from different localities in this belt.

A short time was spent in Toronto, also in the Niagara peninsula, visiting the consumers of silica with a view to determining their requirements of this material.

The moulding sand area at Brockville—a description of which was given in the Mines Branch Summary Report for the year 1916—was again examined, with a view to ascertaining whether this deposit continued westward.

Occurrences of moulding sand were noted in the vicinity of Trenton, Port Hope, and St. Catharines, detailed work on which will be done during the field season of 1918.

A short trip was made in the fall to the property of the Canadian China Clay Co. at St. Remi d'Amherst. At this property the wall rock of the main kaolin deposit consists of a highly shattered quartzite, carrying from 10 to 12 per cent kaolin in the fractures. This material is being treated in the company's mill, and a silica sand being produced which runs over 99 per cent silica.

It is proposed to obtain sufficient data during the field season of 1918 to complete reports on silica in Canada, and foundry moulding sands in Canada.

FUELS AND FUEL TESTING DIVISION.

I

WORK AT THE FUEL TESTING STATION.

B. F. Haanel, *Chief of Division.*

During the year 1917, the Division of Fuels and Fuel Testing was engaged in completing the large scale tests on samples of coal received from the Province of Alberta; the examination and analysis of samples of mine air received from the principal producing coal mines of the Dominion; the chemical analysis and physical examination of oils for the different departments of the Canadian Government; and the general analysis and determinations of the heating value of the samples of coal received from outside sources, and of those required in connexion with work of this division. In connexion with the large scale tests of commercial coal samples, a very large number of analyses of samples of gas are required. This work occupies the entire time of three chemists, during the period the tests are in progress.

The machine shop, which is under the control of this division, completed and had under way a very large amount of work. In addition to the construction and erection of apparatus for the Ore Dressing and Metallurgical Division—which comprised by far the larger part of the output of the shop—the construction of new apparatus, repairs to existing machines and apparatus, and the erection of apparatus in the various laboratories of the Mines Branch, devolved upon the staff of the machine shop.

The dependence of this country upon foreign sources for its supply of oils for manufacturing and various other purposes led to the creation of a laboratory for the special investigation of their value for use in internal combustion motors; and also of the oils obtained by the distillation of coals, lignites, and oil shales, in the retorts specially designed and constructed for this purpose in connexion with the investigation now being conducted with regard to the carbonization and briquetting of Western lignites. The laboratory set aside for this special purpose will be equipped with a semi-Diesel oil engine, and the various apparatus for carrying out complete tests.

During the latter part of the year, Mr. John Blizard, assisted by Mr. E. S. Malloch, prepared a report entitled "The Results of Forty-one Steaming Tests carried out at the Fuel Testing Station, Ottawa." This report embodies the results of the investigations so far conducted with the large scale commercial samples of coal received from the Province of Alberta.

The chemical laboratory staff has, in addition to the regular routine work, been engaged in the investigation covering the carbonization and briquetting of lignites. The progress of this work is set forth in the accompanying report of Mr. Stansfield, Chief Engineering Chemist. This report will also show that the laboratory work has been steadily and rapidly increasing, and that new laboratory space will have to be provided in the very near future, in order that the work may be prosecuted efficiently, and without loss of time.

The summary reports of Mr. E. Stansfield, Mr. A. Anrep, and Mr. A. W. Mantle show in detail the work carried on under their immediate direction.

II

CHEMICAL LABORATORIES OF THE FUEL TESTING STATION.

Edgar Stansfield, *Chief Engineering Chemist.*

The laboratories of the Fuel Testing Station were again utilized not only for the chemical work of the Division of Fuels and Fuel Testing, but also for the chemical work of the Division of Ore Dressing and Metallurgy under the immediate supervision of Mr. H. C. Mabee of that Division. In March Mr. Mabee and his assistants moved into new quarters especially constructed for them, thus considerably relieving the congestion in the laboratories. Moreover, a large office room adjacent to the laboratories, previously occupied by the staff of the Ore Dressing Division, has been converted into a laboratory and equipped for the testing of oils, thus further relieving the congestion. Part of a fuel storage shed is also in progress of conversion into a laboratory and a gas and oil engine room, where, amongst other items, a rotary retort and large gas holders required for the research on lignite are being housed.

The extra laboratory accommodation thus obtained has given a much needed relief; nevertheless, it is extremely desirable that an entirely new laboratory building should be constructed as soon as possible, to replace the scattered and temporary quarters at present available. Meanwhile, many important lines of work have had to be postponed for lack of suitable facilities.

The equipment has been increased by the purchase of the following special apparatus: 2 Becker balances; MacMichael viscosimeter; electric water still; vacuum pump; drying oven; water bath; 2 gas hot plates; 6 electric hot plates; Burrell gas analysis apparatus; 2 gas pressure governors; gas meter; 2 gas holders of 50 cub. ft. capacity; and rheostat. In addition, the following equipment has been designed, and made on the premises: four-chamber mercury trough; oil flash point cups; grease consistency apparatus; electrically heated oil-shale retort; retorts for carbonizing bituminous coal; also a number of retorts, condensers, gas, and electrically heated lead baths, etc., required in connexion with an investigation on lignite. Fifteen volumes have been added to the library, also a large number of reports, bulletins, and journals.

The total number of samples submitted for analysis during the year, exclusive of routine gas samples and the many samples incidental to the lignite investigation of which no count is kept, is 9 per cent greater than in 1916. The increase was mainly due to an increase in the work done for other government departments: notably in the testing of fuel oils and of lubricating oils and greases. Good progress has also been made with special work, other than the testing of samples.

The samples received include: 368 mine air; 145 oils and greases; 71 coal; 65 peat; 17 oil shale; and 10 miscellaneous samples. Three hundred and sixty-eight of the above samples were received in connexion with the testing of mine air; 99 from the Department of Militia and Defence; 66 from field parties of the Mines Branch; 28 from the Department of Public Works; 19 in connexion with the laboratory work of the Fuel Testing Division; 12 from the Board of Railway Commissioners; 11 from the Department of Naval Service; 10 "official" coal mine samples furnished by the Chief Inspector of Mines for the Province of Alberta; 8 from the Geological Survey; 8 from the Commission of Conservation; 5 from the Department of the Interior; 5 from the Department of Marine and Fisheries; 3 from the War Purchasing Commission; 1 from the Department of Customs; and 33 from other parties.

Of the mine air samples, 251 came from British Columbia; 101 from Alberta; and 16 from Nova Scotia; 77 mines belonging to 46 operators being represented.

Special work carried out during the year was mainly concerned with the lignite investigation referred to below. In addition, a number of tests were made on the carbonization of Sydney coal; a retort for the distillation of oil shales was designed, constructed, and tested; and some comparative tests were made on oil viscosimeters. Progress was made also with a compilation of Canadian fuel analyses, which should be ready for publication early in 1918.

In 1915, some preliminary tests were made on the carbonization and briquetting of Canadian lignites; but, owing to the pressure of routine work, this had to be dropped. This investigation was recommenced on a more systematic basis early in 1917; and Mr. Gilmore has been continuously engaged on it since his appointment. Other members of the staff have also assisted from time to time as their regular duties permitted. A comprehensive scheme has been outlined for the investigation, and considerable progress has been made with some sections of the work.

In the carbonization tests which are the starting point in the investigation, the results determined when a sample of lignite is heated include the yield and calorific value of the carbonized residue, the yield, composition, and calorific value of the gas generated; the yield, calorific value, and economic value of the tar oils produced; and the ammonium sulphate yield available. The conditions under which the lignite is carbonized are varied in order to show the influence on the results of: the final temperature to which the charge is heated, the rate of heating, the pressure in the retort, and the atmosphere in the report.

In the first series of experiments small samples were tested in order that very exact control of temperature, etc., might be assured. The conditions were varied as above; but only the yield and calorific value of the carbonized residue were determined. Many tests were made, and tables and curves deduced from the results; and these—together with a discussion on the necessity for treatment of low grade lignite and on the commercial significance of the results obtained—were published in a paper by Messrs. E. Stansfield and R. E. Gilmore, read before the Royal Society of Canada, May 1917 (Trans. Roy. Soc. Canada, series III 1917, vol. XI p. 85), and reprinted in the Canadian Chemical Journal, January and May, 1918.

In the second series of tests, samples of about 5 lb. weight were tested, in order that a sufficient production of gas, tar, etc., might be obtained for all the determinations referred to above. These tests were delayed by the necessity for developing suitable apparatus for heating the lignite with good temperature control, and for completely removing the tar from the gases in such a way that it could easily be collected, weighed, and examined. A satisfactory apparatus was ultimately constructed, and the work was proceeding smoothly at the end of the year. A second interim report will be published early in 1918.

The tests so far made have been on lignite from the Shand mine, Saskatchewan; comparative tests on other lignites will be made later.

In September, the writer attended the third National Exposition of Chemical Industries in New York.

III

INVESTIGATION OF PEAT BOGS.

A. ANREP.

In accordance with instructions, a survey of peat bogs was carried on during the season of 1917; in order to determine the extent, depth, and different qualities of the peat contained in the various bogs.

This investigation started in the middle of June, when the writer left Ottawa with Mr. A. R. Whittier and Mr. P. Bissonnette as temporary assistants, to perform the field work, which was carried on during part of June, July, August, September, and part of October.

The following statement summarizes briefly the results of the season's investigation:—

(1) *Girard* peat bog, situated about 1¾ miles northwest of Girard station, and approximately 8 miles south of St. Johns, in the counties of St. Johns and Napierville, Province of Quebec.

The total area covered by this bog is, approximately, 3,104 acres, with an average depth varying from 3 to 12 feet.

The larger portion of the southern part of the bog is very well suited for the manufacture of peat fuel. It is fairly well humified, with cohesive properties, and has a considerable depth.

While the investigations were being conducted at Girard, I made a preliminary investigation of Pont Rouge peat bog, to ascertain the quality and average depth of the bog, in order to give an opinion regarding the suitability of the bog for the erection of a peat fuel plant. Later on in the season, a proper survey was made of the bog by Messrs. R. S. & W. S. Lea, Consulting Engineers, of Montreal. At that time I also had an interview with Mr. Chas. Staff, Secretary of the Larrowe Milling Company, Detroit, Mich., U.S.A., for the purpose of giving them advice in regard to the erection of a peat litter plant near St. Stephen, New Brunswick.

At the end of July the entire party moved to New Brunswick, where the following bogs were investigated:—

(2) *St. Stephen* peat bog is situated about 4 miles north of St. Stephen, in the parish of St. Stephen, county of Charlotte, New Brunswick.

The total area covered by the bog is 153 acres: which contains two kinds of peat, namely, peat litter and peat fuel.

The peat litter bog consists, approximately, of 71 acres, with an average depth varying from 12 to 30 feet.

The remaining 82 acres represent peat fuel, with an average depth varying from 3 to 12 feet.

The larger part of the bog, with the exception of the northern and southern bays, and a strip of 200 to 400 feet wide around the margin of the bog, is fairly free from humus, and will produce a high grade peat litter.

(3) *Hayman* peat bog is situated about 6 miles north of St. Stephen town, in the parish of St. Stephen, county of Charlotte, New Brunswick.

The total area of this bog is, approximately, 58 acres, with an average depth varying from 3 to 17 feet.

The area of this bog is too small for a large peat fuel manufacturing plant; but the considerable depth of the bog increases the quantity of the fuel contents, and, by

laying out the working field systematically and with great care, this bog can be utilized for the manufacture of machine peat on a small scale.

(4) *Seely Cove* peat bog, situated 4 miles southwest of the road from Pennfield station, in the parish of Pennfield, county of Charlotte.

The total area covered by this bog is, approximately, 123 acres: which contains two kinds of peat, namely, peat litter and peat fuel.

The peat litter area occupies the centre of the whole bog, and consists approximately of 49 acres, with an average depth varying from 12 to 20 feet.

This portion of the bog is very little humified. It has a considerable depth, which will produce a good peat litter suitable for bedding, packing, etc. The remaining 74 acres of the bog consist of peat fuel, with an average depth varying from 3 to 7 feet. As the area is very small, but the peat therein very well humified, it would produce fairly good hand-made peat fuel for domestic purposes.

(5) *Pennfield* peat bog, situated about 4 miles south of St. George, about 4½ miles north of Pennfield station, and about 1½ miles from Pennfield post office, Charlotte county.

The total area covered by this bog is, approximately 680 acres, with an average depth varying from 3 to 8 feet. This peat is practically formed of sphagnum mosses, is practically free from humus, and would produce high grade peat litter; but the bog is not suitable for the manufacture of peat litter on a large scale, as the area is not sufficient. Farmers, however, could cut it by hand and utilize it for stabling purposes, etc.

(6) *Hunter* peat bog, situated about 3 miles northeast of Pennfield station, Charlotte county.

The total area is, approximately, 95 acres, with an average depth varying from 3 to 10 feet.

The peat in this bog is fairly well humified, uniform in quality, possesses fairly high cohesive properties, and is of a sufficient depth to justify the erection of a small modern peat fuel plant.

(7) *Pocologan* peat bog, situated about 5 miles northeast of St. George, and about 4 miles south of Pennfield station, and at certain points the Canadian Pacific railway traverses the eastern part of the bog.

The total area covered by this bog is, approximately 352 acres: which contains two kinds of peat, namely, peat litter and peat fuel.

The peat litter area covers several centrally located sections of the bog, and consists approximately of 107 acres, with an average depth varying from 12 to 16 feet.

The peat litter formation is situated on the top of the fuel of this bog, and forms 5 separate hillocks: one of which is located in the northern portion of the bog; the largest is in the west part of the bog; two are situated in the centre of the bog; and one in the southern portion.

This peat is principally formed by sphagnum mosses, is practically free from humus, and would produce a good peat litter.

The remainder of the area, 245 acres, is of the nature of a peat fuel, with an average depth varying from 5 to 7 feet. The peat in this part of the bog is fairly well humified.

As this well humified area is very much cut up by the occurrences of peat litter, it is not suitable for the erection of a modern and commercial peat fuel plant.

(8) *The Musquash* peat bog, consisting of one large and three small bogs, are situated about 2 miles east of Prince of Wales station, and about 12 miles west of St. John city, New Brunswick.

The larger part of bog No. 1 is situated in the parish of Lancaster; the remainder in the parish of Musquash, county of St. John.

The larger part of bog No. 2 is located in the parish of Musquash; the remainder in the parish of Lancaster, county of St. John.

Bogs Nos. 3 and 4 are in the parish of Lancaster, county of St. John.

The total area covered by bog No. 1 is, approximately, 300 acres. The total area covered by bog No. 2 is, approximately, 8 acres. The total area covered by bog No. 3 is, approximately, 29 acres. The total area covered by bog No. 4 is, approximately, 25 acres.

As the three small bogs are scattered, and each bog is of a very small area, they are not suitable for the manufacture of peat litter on a commercial scale.

Bog No. 1 has an average depth varying from 3 to 14 feet. The peat is practically free from humus, and would produce suitable peat litter.

From October 20 to November 2, preliminary investigations were made of the peat bog near Cochrane, Ontario. The Cochrane bog is situated about 1 mile south of Cochrane station, in Lamarche township, probably continuing into St. John and Hanna townships, county of Timiskaming, Ontario, and runs in a north and south direction.

The total area of the bog of which a preliminary investigation was made is, approximately, 1,400 acres, with an average depth varying from 4 to 21 feet.

At the same time drill holes were made in the bogs south of Cochrane, at the following mileage: 239, 240, 243.

The formation of these bogs is very similar to that of the bog near Cochrane, but the disadvantages of these peat areas lie in the fact that the surface is very heavily wooded, the clearing of which would involve a great expenditure at present.

The total area investigated in the Provinces of Quebec, New Brunswick, and Ontario during the season of 1917 comprises, approximately, 7,115 acres.

IV

STATEMENT OF SUMMARY REPORT OF MECHANICAL SUPERINTENDENT A. W. MANTLE, MINES BRANCH, DEPARTMENT OF MINES.

	Labour.	Material.
Ore Dressing Laboratory..	$5,844 27	$7,473 13
Fuel Testing Division..	1,102 71	329 47
Chemistry Division..	287 28	99 16
Mines Branch, General..	566 72	265 30
Ceramic Division..	123 37	28 99
Structural Materials Division..	216 11	87 77
Metalliferous Division..	83 93	4 60
Non-metalliferous Division..	16 44	4 65
Total..	$8,240 83	$8,293 07

Making a total expenditure, for labour and material, of $16,533.90.

ORE DRESSING AND METALLURGICAL DIVISION.

I

REPORT OF PROGRESS.

G. C. Mackenzie, *Chief of the Division.*

The writer, while supervising the work of this Division, devoted the greater part of his time to the work of the Canadian Munition Resources Commission, of which he is the Secretary.

The Assistant Engineer, Mr. W. B. Timm, supervised the plant operations and test work at the Ore Testing Laboratories, and was assisted by Mr. C. S. Parsons, who also conducted a series of tests on the adaptability of Canadian Wood Oils for Ore Flotation. The results on this work is contained in pamphlet form edited by the Canadian Mining Institute under the title of "Canadian Wood Oils for Ore Flotation," by R. E. Gilmore and C. S. Parsons.

During the year the concentration of molybdenite ores on a commercial scale was continued. Ores were received from the various localities in the Dominion where molybdenite prospects were being opened up, 1,657 tons of ore were treated having a content of 40·5 tons of molybdenite.

During the year the process of milling and concentrating molybdenite ore was modified, and instead of dry milling and concentration by film flotation, wet milling and concentration by Oil Flotation in Callow Pneumatic Cells was adopted. This latter method is the one in most general use in the concentration of molybdenite ores at the present time.

During the first portion of the year the Mines Branch, through an arrangement with the Imperial Munitions Board, acted as millers and assayers for the Board, and continued to do the sampling and assaying on ferro-molybdenum throughout the year.

A shipment of quartz and barytes was milled for the Imperial Munitions Board, besides the many samples of ores and minerals which were prepared for analysis in the chemical laboratories of this division.

Although the plant was operated on a commercial scale for the treatment of molybdenite ores, a large amount of test work was performed.

A list of the ores received for experimental testing and the results of the test work follows:—

Molybdenite Ores Treated, and Concentrates Reduced, in Mines Branch Ore Dressing Laboratories, for the year ending December 31, 1917.

Shipped by	Locality.	Crude Ore Received, Lb.	% MoS_2.	Lb. MoS_2.	Molybdenite Concentrates Produced.	% MoS_2.	Lb. MoS_2.	Actual % Recovery
Armstrong, R. M.	Ashdod, Renfrew Co., Ont., S. ½ Lot 18, Con. I	42·0	46·14	19·3788	....	......	....	
Bourgault, A.	Brougham Twp., Renfrew Co.	1,064·5	0·57	6·0676	....	......	....	
Bolan, J. A.	Campbell's Bay, Que.	1,795·0	0·60	10·770	....	......	....	
Canadian Wood	Moss Mine, Lots 9 and 10, Range VII, Onslow Twp., Pontiac Co., Que.	1,475,088·5692	3·244	47,850·7302	....	......	....	

MOLYBDENITE ORES TREATED, and Concentrates Reduced, in Mines Branch Ore Dressing Laboratories, for the year ending December 31, 1917—*Continued.*

Shipped by	Locality.	Crude Ore Received, Lb.	% MoS_2	Lb. MoS_2	Molybdenite Concentrates Produced.	% MoS_2	Lb. MoS_2	Actual % Recovery
Canadian Express Co.	Burnt in transit, and retreated	492·0	32·41	159·4572				
Canadian Molybdenite Co.	W. ½ Lot 27, Con. IV, Bagot Twp., Renfrew Co.	1,489·0	3·35	49·9323				
P. H. Chabot	Eardley, Wright Co., S. ½ Lot I, Range IV	3,931·0	4·93	193·7427				
Edward Chaput	S. ½ Lot 1, Range VII, Eardley Twp., Wright Co., Que.	65,301·5	0·771	503·5355				
Chisholm Mine	Lot 5, Con. XIV, Sheffield Twp., Addington Co., Ont.	10,253·5	5·646	578·9256				
Dominion Molybdenite Co.	Moss Mine, Lots 9 and 10, Range VII, Onslow Twp., Pontiac Co.	1,091,929·86	1·924	21,002·2953				
M. T. Foley	Property adjoins Dominion Molybdenite	25,004·5	1·54	385·1102				
Grey & Grey	Lot 32, Con. XVI, Monmouth Twp., Haliburton	117·141·0	0·205	240·14				
M. W. Hotchkins	Near Maniwaki, Que.	711·0	4·16	29·5723	109,590·5	57·42	62,931·2055	*77·67
*International Mol. Co., Renfrew	Lots 16 and 17, Con. XI, Brougham Twp., Renfrew, Ont.	257,733·5242	2·114	6,049·1851				
W. R. Kelly	Lot 6, Range IX, Eardley Twp., Wright Co., Que.	1,980·5	0·91	18·0225				
R. J. Lillico	Lots 14 and 15, Con. XII, Monmouth Twp., Haliburton, Ont.	110,307·806	1·01	1,116·8114				
Maratime Optical Co.	New Ross, N.S.	674·5	1·66	11·1967				
The Mining Cor'p of Canada	Lots 1 and 2, Range III, Aldfield Twp. Pontiac, Que.	51,613·0	0·06	30·9678				
Wm. C. McCoy	Lot 34, Con. XI Lyndock Twp., Renfrew	2,058·0	0·80	16·47				
A. R. McDonald		14·5	62·48	9·0596				
D. McEachern	Near Ollala, B.C.	4390·0	17·11	751·129				
C. R. Normandin	New Ross, Lunenburg Co., N.S.	1,033·0	1·03	10·6399				
Opeongo Mining Syndicate	Opeongo, Ont.	43,446·5	0·385	167·269				
Jas. Stewart	Gabarous, C.B.	3,474·0	2·49	86·5026				
A. W. Taylor	W. ½ Lot. 28, Con. IV, Bagot Twp., Renfrew, Co.	42,584·5	3·40	1,447·873				
Tivani Electric Steel Co.	Mill sweepings	1,259·9354	21·80	274·7013				
	Total	3,314,814·1948	2·444	81,019·4862				

* Concentrates from International ore not yet ready for shipment and are not included in total MoS_2 produced. When added, actual recovery will be 84·14%.

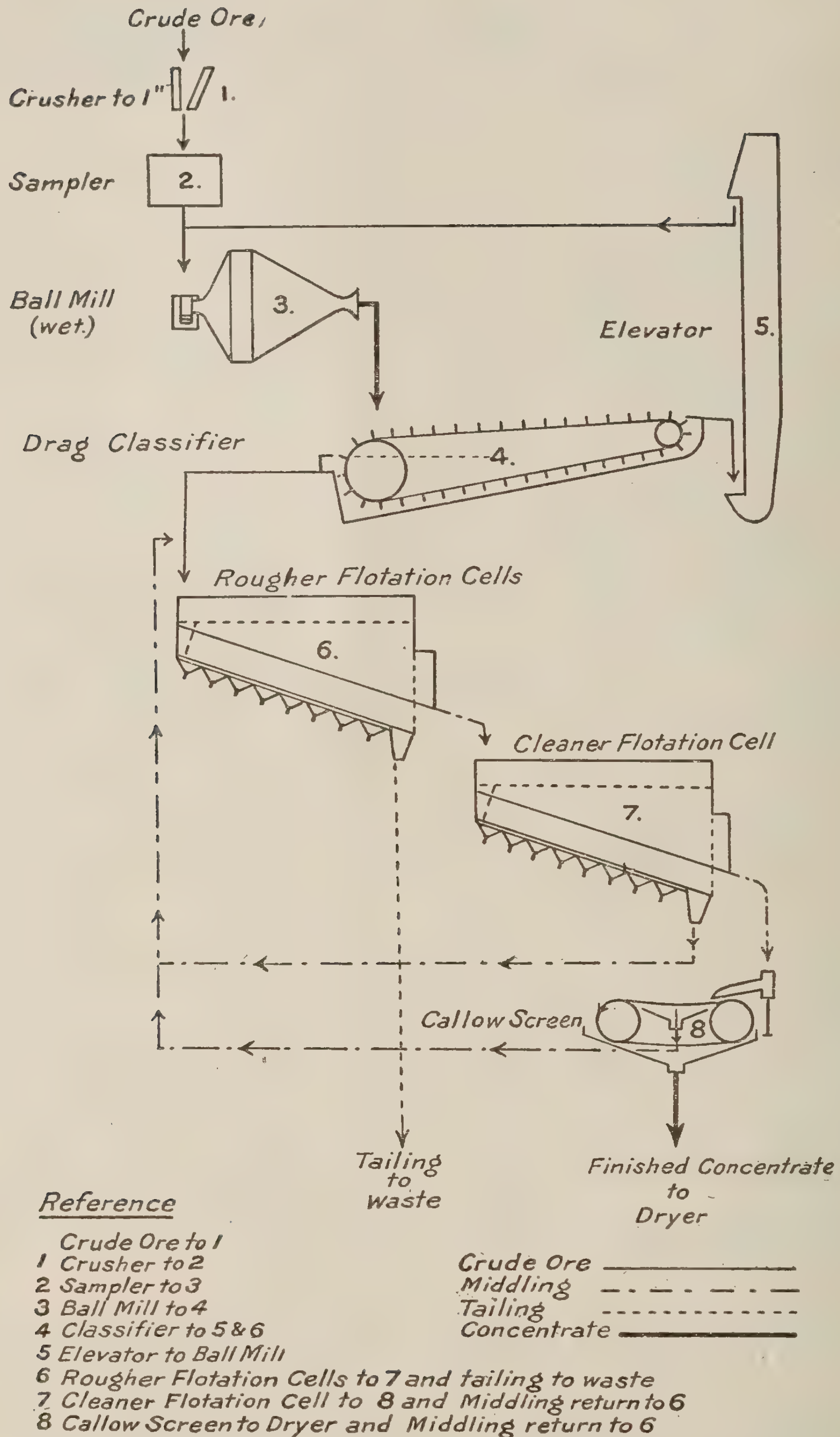


Fig. 2.—Flow sheet for Molybdenite Mill, showing method of wet milling and concentration by oil flotation in callow pneumatic cells.

II

ORES TESTED AND REPORTS THEREON.

W. B. TIMM, *Assistant Engineer.* C. S. PARSONS, *Assistant Engineer.*

The following ores have been tested and reports made thereon during the calendar year 1917:—

No. of Test.	Ore or Rock.	Locality.	Shipper.	Weight.	
				Ton.	Lb.
56	Gold	Dryden, Ont.	E. G. Rognon, Dryden, Ont.	......	185·5
57	Sandstone	Nepean, Ont	Geo. H. Megloughlin, Ottawa, Ont.	......	702
58	Garnet	....	Jas. H. Mason, Toronto, Ont.	......	250
59	Molybdenite	Alice Arm, B.C	Internationa Molybdenum Co., Renfrew Ont.	......	1,145
60	Molybdenite	....	Jas. Stewart,, New Glasgow, N.S		3,474
61	Tungsten	....	G. F. Murphy, Halifax, N.S.	....	505
62	Manganese	Hillsborough, N.B.	F. M. Thompson, Hillsborough, N.B.	......	500
63	Molybdenite and gold.	New Hazelton, B.C.	New Hazelton Gold-Cobalt Mines, Ltd., New Hazelton, B.C.	......	30
64	Iron	Kaministikwia, Ont.	J. E. Marks, Kaministikwia, Ont	......	239
65	Manganese	Canaan, N.B	F. G. Jonah, Canaan, N.B.	1	
66	Silver-lead	....	Mr. Smith-Curtis, Kamloops, B.C.	......	30
67	Manganese	Rossville, N.S.	Rossville Manganese Co., Halifax, N.S.	28	
68	Molybdenite	Kakabeka Falls, Ont.	Robert Gamble, Ottawa, Ont.	......	
69	Slag ferro-molybdenum.	Belleville, Ont.	Tivani Electric Steel Co., Belleville, Ont.	17	575
70	Chromite	Black Lake, Que.	Dom. Mines & Quarries, Ltd., Black Lake, Que.	......	240
71	Chromite	Black Lake, Que.	The Mutual Chemical Co., Black Lake, Que.	......	160
72	Chromite	St. Cyr, Que.	Quebec Asbestos & Chrome Co., St. Cyr, Que.	......	600
73	Chromite	St. Cyr, Que.	Quebec Asbestos & Chrome Co., St. Cyr, Que.	33	1,158
74	Sandstone	Nepean, Ont.	Nepean Sandstone Quarries, Ltd., Ottawa, Ont.	35	

Test No. 56.

Description of sample.—A sample of gold ore weighing 185·5 pounds was received March 23, 1917, at the testing plant of the Ore Dressing and Metallurgical Division, from E. G. Rognon, Dryden, Ont. The ore was the free milling type, containing numerous nuggets and flakes of free gold in a clean quartz gangue.

Analysis of samples.—The whole shipment was reduced by alternate crushing and sampling until a 6-pound sample was obtained through two 35-mesh screens. This 6-pound sample was divided into two equal parts by passing through a Jones riffle-sampler. Each of these two portions was sampled down separately in order to obtain duplicate samples of the whole shipment for assaying. The assays of these two samples checked closely.

Sample No. 1—29·90 oz. of gold per ton.
Sample No. 2—29·86 oz. of gold per ton.

Method of treatment.—An amalgamation test was made on each of the above two samples. A charge of 1,000 grams of ore was weighed out from each of the above two samples, and placed in a separate pebble mill, with 10 per cent by weight of mercury. Enough water was added to make a pasty pulp that would just hold up the globules of mercury. These charges were then ground with flint pebbles for two hours. The charge was then washed out, and panned in an amalgamated pan, in order to separate the mercury, and the following results were obtained:—

Results—

Sample No. 1.

Weight of ore charged to mill..	1,000 grams.
Assay in ounces troy per ton 2,000 pounds..	29·90
Weight of tailings obtained..	999·0 grams.
Assay of tailing..	0·86 oz.
Per cent of gold extracted..	97·15%

Sample No. 2.

Weight of ore charged to mill..	1,000 grams.
Assay in ounces troy per ton 2,000 pounds..	29·86
Weight of tailing obtained after amalgamation..	999·0 grams.
Assay in ounces per ton..	0·84 oz.
Per cent of gold extracted..	97·2%

Test No. 56-B.

Method of treatment.—The remainder of the shipment was crushed to 20 mesh, and charged into ball mills, and amalgamated as in the above two samples. After amalgamation in the mill, the mercury was panned out, retorted, and the sponge melted to bullion. An assay was made of the tailing and of the recovered bullion for fineness.

Results—

Heads—	
Weight of ore charged to ball mills..	190 pounds.
Assay in ounces troy per 2,000 pounds ton..	29·87
Content of fine gold..	2·8376
Bullion—	
Weight of bullion obtained..	3·18 oz.
Assay of bullion for fineness..	·877 fine.
Content of fine gold in bullion..	2.78886 oz.
Recovery of gold in bullion..	98·28%
Tailing—	
Weight of tailing..	190 pounds.
Assay of tailing..	2·04 oz.
Content of fine gold..	0·1938 oz.

Summary of results.—A summary of the above tests shows that in the two small tests 97·15 per cent and 97·2 per cent of the gold was recovered by amalgamation; and in the test using the larger amount of ore 98·28 per cent of the gold was extracted. The bullion obtained was only 877 parts fine.

Conclusion.—It is evident that the above tests show that gold from this sample can be readily extracted by amalgamation, and that a high recovery can be made.

Test No. 57.

Description of sample.—A shipment of 702 pounds of sandstone was received at the Ore Testing plant of the Ore Dressing and Metallurgical Division from Mr. Geo. H. Megloughlin, of the Nepean Sandstone Quarries, Ltd., Ottawa, Ont., June 11, 1917.

Products desired.—A crushing test on the sandstone was desired in order to obtain data for the erection of a crushing plant for this stone.

Method of procedure.—The procedure was as follows: Sandstone, wt. 702 lb. Jaw crusher set at 1½″ opening. Roughing rolls set at ½″ opening. Time, 8 min. 16-mesh

screen. 16 mesh, wt. 267 lb.; 16 mesh, wt. 435 lb. Rolls set at 1/16″ opening. Time, 3 minutes. 16-mesh screen. 16 mesh, wt. 53 lb.; 16 mesh, wt. 214 lb.

Conclusion and recommendations.—First—Sandstone crushes very easily. Our 12-inch by 8-inch Blake type jaw crusher has a capacity of about 5 tons per hour on this material, crushing to 1½ inches.

Second—With our rolls set at ½-inch opening, the time required to pass the 702 pounds through was 8 minutes. Our feeders to the rolls were not changed, but were left at the feed used for much harder and tougher rock. On the sandstone they would have the same capacity as our crusher, namely, 5 tons per hour.

Third—With the crusher set at 1½ inches and the rolls at ½ an inch, 62 per cent of the sandstone passes a 16-mesh screen, and 38 per cent stays on the screen to be reground.

Fourth—With the rolls set at 1/16-inch opening, 30 per cent of the original feed passes the 16-mesh screen, and 8 per cent remained on the screen to be returned to the second set of rolls.

Fifth—Our rolls are somewhat worn by continual use on hard ores, hence the greatest efficiency could not be obtained. With a perfectly flat surface on the rolls, less than 5 per cent of the original feed would be returned to the circuit.

Sixth—It may also be found that a greater output could be obtained by first crushing to 2-inch; rolling to ⅝-inch or ¾-inch, and with finishing rolls set almost touching. This would throw more work on the finishing rolls which could easily stand it.

Test No. 58.

Description of sample.—A sample garnet ore weighing 250 pounds, was received June 4, 1917 at the testing plant of the Ore Dressing and Metallurgical Division, from Jas. H. Mason, Toronto, Ont.

The garnet was associated with about 10 per cent of foreign material, consisting chiefly of quartz calcite and hornblende.

Object of test.—A high grade garnet product was desired on which the owner wished to conduct tests as to its abrasive properties.

Method of treatment.—The ore was crushed to 20 mesh, and sized. It was found by examination under the microscope, that the garnet is not entirely freed until it is reduced to 50 mesh. Concentration tests were conducted on the Laboratory Wilfley table, the Overstrom table, and the Ullrich magnetic separator.

Summary and conclusion.—Although a concentration was obtained on the tables, and a fair garnet product was produced, the recovery of the garnet was much lower than by magnetic separation, on account of having to sacrifice considerable garnet in the tailings, due to the slight difference in specific gravity between the garnet and gangue material. On the other hand, magnetic separation was very satisfactory. A higher grade concentrate was produced with a low garnet content in the tailing.

The products were shipped back to Mr. Mason for his tests, as stated above.

Test No. 59.

Description of ore.—A shipment of 25 bags of molybdenite ore was received at the testing plant of the Ore Dressing and Metallurgical Division, from the International Molybdenite Co., Renfrew, Ont.

The ore was obtained from Alice Arm, British Columbia, and consists of fine grains and flakes of molybdenite, in a quartz gangue.

Method of treatment.—A number of small samples were taken from the shipment, and ground to different sizes, by placing in a small ball mill. These samples were treated by the oil flotation process in a set of small laboratory callow cells.

Description of treatment.—A sample weighing 1,000 grams was charged to a small ball mill, and water was added to make a pulp of 1:1. The oil, and other reagents required, were also added to the ball mill. When the ore had been ground to the required size, the mill was opened, and the charge poured onto the flotation cells.

Conclusion.—It is evident from the results tabulated in the above table, that the ore can be easily concentrated by oil flotation, and a clean concentrate obtained with a high extraction.

It has generally been considered that this ore required very fine grinding, in order to free the molybdenite, but tests 3 and 4 show, that it is not necessary to grind the ore any finer than through a 65-mesh Tyler standard screen; at least 50 per cent, however, of this product, ground through the 65-mesh screen, would pass 200 mesh.

The first two tests were run in a neutral pulp with city tap water, and the last two tests in a pulp to which a little lime had been added. In the first two tests, eucalyptus oil was used as the frother, and in the last two, crude turpentine from the Pensacola Tar & Turpentine Co., Ltd., Gull Point, Fla., U.S.A.—their No. 75. The increase in the grade of the concentrate was produced by the addition of lime and not by the change of frothing oils. The minimum amount of lime required was not determined. It must be borne in mind that while the addition of lime when floating the callow cells produces a beneficient effect it may have an entirely different effect in the agitation type of machine. The addition of lime has another advantage, namely, that it causes a better emulsion of the coal oil, preventing any free oil from floating in the surface of the pulp in the cell and killing the froth.

Oil Flotation tests on Alice Arm ore.

Heads.			Concentrates.			Middlings.			Tailing.			Total ext. 70%.	Reagents.			
Charge in Grams.	Calculated MoS_2. Analysis.	Mesh of Pulp.	Wt. Grms.	Analysis MoS_2.	Recovery %	Wt. Grms.	Analysis MoS_2.	P. C. Crude Content.	Wt. Grms.	Analysis MoS_2.	P. C. Loss.	Recov. of Mids.	Frothing Oil.	Collecting Oil.	Total Amount Oil.	Other Reagents.
1,000	0·74	—150	20·5	28·3	78·4	20·5	2·23	6·1	959·0	0·12	15·5	82·8	Eucalyptus oil 10%	Fuel oil 90%	3	None.
1,000	0·74	—150	21·5	27·4	78·4	16·0	2·26	6·1	962·5	0·12	15·5	82·9	Eculayptus oil 10%	Coal oil 90%	2	None.
1,000	2·63	— 65	30·7	66·51	77·6	20·25	10·72	8·30	949·05	0·39	14·1	83·9	P.T.T. Co. No. 75 20%	Coal oil 80%	2 2	Added a little lime.
1,000	3·28	— 65	50·6	60·45	93·20	40·55	2·36	2·90	908·85	0·14	3·90	95·0	P.T.T. Co. No. 75 20%	Coal oil 80%	2	Added lime.

Test No. 60.

Description of sample.—A sample of molybdenite ore weighing 3,474 pounds was received June 23, 1917, at the Testing Plant of the Ore Dressing and Metallurgical Division, from James Stewart, New Glasgow, Nova Scotia.

The molybdenite was associated with siliceous gangue material.

Analysis of sample.—The whole shipment was crushed down, and a sample was taken and assayed for molybdenite and copper. The result was as follows:—

Molybdenum Sulphide (MoS_2)	— 2·49 per cent.
Copper	— 0·02 "

Method of treatment.—Two small samples weighing 1,000 grams each, were taken and ground in a small ball mill, to pass respectively 100-mesh and 40-mesh screens. They were then treated by the oil flotation process in a set of small callow cells.

Description of treatment.—A sample weighing 1,000 grams was placed in a small ball mill, and water was added to form a pulp of 1:1. The oil and other reagents required were added to the ball mill, and the whole charge ground together until the ore was reduced to the required size. The mill was then opened, and the charge washed in to the flotation cells.

Summary and conclusions.—The results of two tests are tabulated in the accompanying table. In test No. 1 the extraction of the molybdenite was 90·1 per cent, and in test No. 2 the extraction was 88·2 per cent; the concentrates from the two tests assay, respectively, 49·3 per cent molybdenum sulphide, and 59·7 per cent molybdenum sulphide. Experience has shown that a much higher grade concentrate is produced from the commercial size machines than can be obtained from the small laboratory testing cells. The oil used was a mixture of 20 per cent crude turpentine and 80 per cent coal oil, and the amount used was in the ratio of 2 pounds of this mixture per ton of ore. The crude turpentine was obtained from Pensacola Tar and Turpentine Co., Gull Point, Fla. This product is quite different from the ordinary commercial turpentine. The addition of a small quantity of lime—about 0·25 per cent or 5 pounds per ton of ore—seemed to be beneficial, in that it caused a better emulsification of the coal oil, preventing any floating on the surface of the pulp in the cell, and killing the froth. It may be found, however, that with continuous operation in actual practice, that the lime may be dispensed with.

TEST NO. 1.—Showing result obtained by oil flotation on callow cells.

Test No.	Heads.			Concentrate.			Middling.			Tailing.			Total ext. 70%	Reagents.			
	Charge Grams.	Calculated analysis.	Mesh of Pulp.	Wt. Grms.	Analysis P.C. MoS_2.	Recovery %	Wt. Grms.	Analysis P.C. MoS_2.	P.C. of Metal Con. of Crude.	Wt. Grms.	Analysis P.C. MoS_2.	P.C. of Metal lost.	Recovery Cont. of Mids.	Frothing Oil.	Collecting Oil.	Amount used lb. per ton.	Other Reagents.
1	1,000	2·21	—100	40·5	49·3	90·1	16·0	0·12	0·09	943·5	0·23	9·80	90·1	P.T.T. Co. No. 75 20%	Coal oil 80%	2	Small amount lime applied 5 lb. per ton.
2	1,000	1·82	—40	26·0	59·7	85·2	65·0	1·21	4·30	909·0	0·21	10·50	88·2	P.T.T. Co. No. 75 20%	Coal oil 80%	2	Small amount lime applied. 5 lb. per ton.

Test No. 61.

SCHEELITE ORE.

One barrel of scheelite ore was received at the Ore Testing Laboratories from G. F. Murphy, Esq., Nova Scotia Technical College, Halifax.

Weight of ore received	505·0 pounds.
Analysis	37·50% WO_3
Content	189·375 pounds WO_3

The ore was crushed to 20 mesh and run on the Overstrom table.

Concentrates obtained	225 pounds.

The tailings were reground to 40 mesh, and run over the same table.

Concentrates obtained	5 pounds.

The final weights and analysis were as follows:—

Concentrates—	
Weight	230 pounds.
Analysis	69·27% WO_3
Content	159·321 pounds, WO_3
Recovery	84·13 per cent.
Tailings—	
Weight	140 pounds.
Analysis	0·95% WO_3
Content	1·33 lb. WO_3
Loss	0·70 per cent.
Slime loss in treatment—	
Weight	135 pounds.
Calculated analysis	21·28% WO_3
Content	28·724 lb. WO_3
Percentage loss	15·17 per cent.

This ore should have been sized or classified, and the slimes treated on a slime table.

Test No. 62.

SINTERING TESTS ON DAWSON SETTLEMENT BOG MANGANESE ORE.

A shipment of 500 pounds of bog manganese ore was received July 17, 1917, at the testing plant of the Ore Dressing and Metallurgical Division, from F. M. Thompson, Hillsborough, N.B.

The ore was sampled and analysed and found to contain as follows:—

Dried at 110°C. for 1½ hours	33·80%	metallic manganese.
Ignited at red heat for 1½ hours	38·46%	" "
Loss of weight on ignition	56·04%	" "
Crude wet ore (by calculation)	16·91%	" "

A number of tests were made in an endeavour to sinter the crude wet ore by the addition of varying quantities of fuel in the form of either coke, soft coal, or charcoal. A mixture of soft coal and coke was the best. The amount of fuel was increasd from 10 per cent by weight of the *ore charge,* up to as high as 40 per cent, without forming any more than a few isolated pieces of sinter. Different methods of mixing the charge were tried, and apparently the most successful method was by rolling the charge in a small ball mill without the addition of balls. The other methods of mixing tried were: (1) rolling on a canvas sheet, and (2) by placing in the ball mill with steel balls.

A second series of tests were made by first drying the ore and then adding the percentage of water required for each test. A new difficulty was encountered with this method. It was found that even under a vacuum of 12 inches of water no air could be drawn through the charge. The amount of water was gradually increased to as high as 20 per cent, but the charge still remained impervious. The thickness of the bed was also reduced from 4 inches to 2 inches, without improvement. An endeavour was

then made to increase the porosity of the charge, by mixing in coke (20 mesh size), and as much as 20 per cent coke was added without having any noticeable effect.

A third series of experiments were made by adding a portion of dry ore to the crude wet ore in the charge. By this method some fairly promising yields of sinter were obtained. A charge made up as follows yielded 14 pounds of sinter:—

Crude ore	30 pounds.		
Dry ore	5 "	=14·3%	
Coarse coke (10 mesh)	3 "	= 8·6%	17·2%
Pulverized coal	3 "	= 8·6%	

This charge was mixed by rolling in a ball mill without the addition of balls. Analysis of this sinter was as follows:—

Manganese	36·41%
Silica	13·68%

When the proportion of dry ore was increased to 33 per cent of the total weight of the ore in the charge, the mixture became impervious to the air under a vacuum of 12 inches of water.

Conclusions.—1. That the ore in the crude wet state, containing 50 per cent moisture, cannot be sintered even with the addition of 40 per cent fuel.

2. That when the ore is dried, and the moisture, required for sintering purposes, added up to at least 20 per cent, the charge becomes impervious to the air draft.

3. By mixing a proportion of dry ore with the wet ore, and with the addition of coarse coke, a fair yield of sinter can be obtained, but only with a relatively large consumption of fuel which is objectionable from the point of cost, and lowers the maganese content of the sinter due to addition of silica, etc., contained in the ash from the fuel.

Test No. 63.

Description of sample.—A small sample of ore was received from the New Hazelton Gold-Cobalt Mines, Ltd., New Hazelton, B.C.

The predominating mineral in the ore was molybdenite, but gold and cobalt were also present in appreciable quantities.

Analysis of sample.—This analysis was obtained by calculation from the analysis of the concentration products:—

Molybdenum sulphide (MoS_2)	6·76%
Gold in ounces troy per 2,000 pounds ton	0·760
Silver	trace.
Cobalt	0·64%

Method of treatment.—A sample weighing 1,000 grams was ground wet in a small ball mill to pass a 40-mesh screen. It was then treated by oil flotation in a set of small laboratory size callow cells.

Description of treatment.—A sample weighing 1,000 grams was placed in the small ball mill, as mentioned above, and enough water was added to make a good grinding pulp. The oil and other reagents required were added to the charge in the ball mill, and the whole ground together until the ore was reduced to the required size. The mill was then opened, and the charge washed into the flotation cells.

Summary and conclusions.—The results from the test are tabulated in the accompanying table.

The oil used was a mixture of 20 per cent crude turpentine and 80 per cent kerosene oil, and the amount used was in the ratio of 2 pounds per ton of dry ore. The crude turpentine was obtained from the Pensacola Tar & Turpentine Co., Gull Point, Fla., and is known as their number 75. We have found the above mixture to be the most satisfactory oil for floating molybdenite ore.

The fact that the greater part of the gold is collected in the molybdenite concentrates rather complicates the problem of its recovery. There was not sufficient concentrate left after the necessary assays were made on which to make any tests, but two methods of treatment suggest themselves, namely, either by direct cyaniding or by careful roasting of the molybdenite to the oxide, and subsequent leaching with an ammoniacal solution to dissolve out the molybdenum oxide, and thereby leave the gold in the residue. However considerable experimental work on a larger quantity of ore would be required to arrive at any conclusions regarding the above suggestions.

It is also possible that by using some other collecting oil, such as pine tar or coal tar, that all the gold values could be obtained in the concentrate, which would leave only the one product to be treated for the recovery of the gold content.

In order to make the above experiments, a thousand-pound sample will be required.

TABLE No. 1.—Showing results obtained on the recovery of the Molybdenite values by oil flotation.

Heads.			Concentrates.			Middling.		Tailing.		Total ext. 70% recovery of Content of Mids.	Reagents.			
Charge Grams.	Calculated Analysis P.C. MoS_2.	Mesh % Pulp.	Wt. Grams.	P.C. MoS_2.	P.C. recovery.	Wt. Grams.	P.C. MoS_2.	Wt. Grams.	P.C. MoS_2.		Frothing Oil.	Collecting Oil.	Amount used lb. per ton.	Other Reagents.
1,000	6·76	—40	78·0	78·6	90·6	22	9·90	900	0·46	92·9%	P.T.T. Co. No. 75 20%	Kerosene oil 80·0%	2	None.

TABLE No. 2.—Showing assays of Products obtained by Concentration.

Product.	P.C. MoS_2.	Ozs. Gold.	Ozs. Silver.	P.C. Cobalt.
Concentrate	78·6	5·5	Trace.	Trace.
Middling	9·9	1·16	Trace.	....
Tailing	0·46	0·34	Trace.	0·71

Test No. 64.

BANDED IRON ORE.

A shipment of three bags was received on September 27, 1917, from J. E. Marks, Esq.:—

Weight received	239 pounds.

The ore was a banded magnetite-hematite and gave the following analysis:—

Total iron as Fe	37·19%
Hematite Fe_2O_3	17·98%
Magnetite Fe_2O_3	33·97%

The ore was crushed to 4 mesh and sampled. The 4-mesh material was sized on 8, 16, and 30 mesh.

— 4 + 8	Weight	128 lb.
	Analysis	36·32% Fe.
	Content	46·49 lb. Fe.
— 8 + 16	Weight	55 lb.
	Analysis	35·83% Fe.
	Content	19·71 lb. Fe.
—16 + 30	Weight	26 lb.
	Analysis	35·93% Fe.
	Content	9·34 lb. Fe.
—30	Weight	30 lb.
	Analysis	38·83% Fe.
	Content	11·65 lb. Fe.

There was not sufficient ore to jig separately so the – 16 + 30 size was jigged first followed by the coarser sizes, while – 30 material was run over the table.

Weight to Jig	202·5 lb.
Calculated analysis	36·15% Fe.
Content	73·20 lb. Fe.
Concentrates No. 1 Jig	54·5 lb.
Analysis	55·26% Fe.
Content	30·12 lb. Fe.
Recovery	41·15%
Concentrates No. 2 Jig	26·0 lb.
Analysis	49·91% Fe.
Content	12·98 lb. Fe.
Recovery	17·73%
Hutch No. 1 Jig	1·5 lb.
Analysis	55·04% Fe.
Content	0·83 lb. Fe.
Recovery	1·13%
Hutch No. 2 Jig	3·5 lb.
Analysis	40·29% Fe.
Content	1·41 lb. Fe.
Recovery	1·93%
Tailings	90·0 lb.
Analysis	21·50% Fe.
Content	19·35 lb. Fe.
Loss	26·43%
Clean up of Jig Bed	27·0 lb.
Analysis	36·54% Fe.
Content	9·87 lb. Fe.
Per cent Fe	13·35%

NOTE.—With the No. 2 Jig adjusted properly the No. 2 Hutch and No. 2 Concentrates should run 50 per cent Fe.

Weight of—30 material to table	29·0 lb.
Analysis	38·83% Fe.
Content	11·26 lb. Fe.
Concentrates obtained	5·0 lb.
Analysis	63·37% Fe.
Content	3·17 lb. Fe.
Recovery	28·15%

Middlings obtained	7·0 lb.
Analysis	43·80% Fe.
Content	3·07 lb. Fe.
Recovery	27·26%
Tailings obtained	7·0 lb.
Analysis	20·48% Fe.
Content	1·43 lb. Fe.
Loss	12·70%
Loss in handling	10·0 lb.
Calculated analysis	35·90% Fe.
Content	3·59 lb. Fe.
Percentage loss	31·88%

The jig tailings and clean-up of jig bed were recrushed to 30 mesh, and run over the table with the following results:—

Weight to table	116·5 lb.
Calculated analysis	25·00 % Fe
Content	29·125 lb. Fe
Concentrates obtained	15·0 lb.
Analysis	55·51 % Fe
Content	8·33 lb. Fe
Recovery	28·60 %
Middlings obtained	13·5 lb.
Analysis	33·71 % Fe
Content	4·55 lb. Fe
Percentage Fe values	15·62
Tailings obtained	55·0 lb.
Analysis	13·66 % Fe
Content	7·51 lb. Fe
Loss	25·79 %
Slime Loss	33·0 lb.
Calculated analysis	26·47 % Fe
Content	8·735 lb. Fe
Loss Fe values	29·99 %

A summary of the various products would be as follows:—

Products.	Weight — lb.	Analysis — % Fe	Content — lb. Fe	Recoveries or Losses.
Conctes. Jig No. 1	54·5	55·26	30·12	35·13
Conctes. Jig No. 2	26·0	49·91	12·98	15·15
Hutch Jig No. 1	1·5	55·04	0·83	0·97
Hutch Jig No. 2	3·5	40·29	1·41	1·64
Table Concentes. No. 1	5·0	63·37	3·17	3·70
Table Mids. No. 1	7·0	43·80	3·07	3·58
Table Conctes. No. 2	15·0	55·51	8·33	9·72
Tailings and Slime Losses	118·5	21·78	25·815	30·11
Totals	231·0	37·11	85·725	100·00
Total Concentrates	112·5	53·25	59·910	69·89
Total Tailings and Slime Losses	118·5	21·78	25·815	30·11
Totals	231·0	37·11	85·725	100·00

Ratio of concentration, 1:2.

A large-scale test conducted some time ago on a similar ore gave much the same results.

Ratio of concentration, 1:2.
The grade of the concentrates around 55 per cent Fe.
The recovery of Fe values between 70 per cent and 75 per cent.
The tailing analysis around 20 per cent Fe.

Test No. 65.

SINTERING TESTS, BOG MANGANESE ORE FROM CANAAN, N.B.

A shipment of 20 bags of bog manganese was received from F. G. Jonah, Canaan, New Brunswick.

The ore was sampled and gave the following analyses:—

Manganese dried at 110°C..	47·82%
" ignited ore..	53·45%
Iron, iron in ore dried at 110°C.	5·40%
" ignited ore..	6·02%
Silica in ignited ore..	4·59%
Phosphorus in ignited ore..	0·358%

A number of sintering tests were made on the crude which contained over 40 per cent moisture. The chief difficulty encountered was due to the charge grinding under the air draft. An endeavour was therefore made to increase the porosity of the charge by mixing in coarse coke (10-mesh size). This was fairly successful, and a good sinter was obtained; but the yield was small. A charge made up as follows yielded 6 pounds of sinter:—

Crude ore..	25 lb. = 69·4%
Dry ore..	5 " = 13·9%
Coarse coke..	3 " = 8·3%
Pulverized coal..	3 " = 8·3%

An analysis of the sinter was as follows:—

Manganese..	44·19%
Iron..	13·53%
Silica..	12·29%
Phosphorus..	0·532%

Test No. 66.

LEAD-SILVER ORE.

A sample of 30 pounds of ore was received from Mr. Smith-Curtis, Kamloops, B.C.

The sample was supposed to be representative of the ore from the Homestake Mine, situated 3 miles west of Squaw Bay, Adams Lake, B.C., and gave the following analysis:—

Lead..	0·65%
Copper..	0·21%
Iron..	0·71%
Gold..	0·02 oz.
Silver..	13·47 oz.

Flotation tests were conducted to obtain a marketable concentrate, or a concentrate that could be chloridized and leached at the mine.

The tests were conducted on the small laboratory callow testing machine. A portion of the ore was taken and crushed to 100 mesh for these tests:—

Run No. 1.—1,000 grams of the ore were put in a pebble mill, to which were added 1·5 c.c. of oil mixture, 40 per cent No. 26 F.P.L., and 60 per cent base, and 3·5 c.c. of NaOH solution as a deflocculant, and the whole mixed with about 2,000 grams of water for seven minutes before given to the testing machine. A concentrate, middling, and tailing product were made.

—	Concentrates.	Middlings.	Tailings.
Weight	75 grams	50 grams	875 grams
Analysis—Lead	8·75 %	Trace	Trace
Copper	2·60 %	0·05 %	Trace
Iron	3·28 %	1·48 %	0·13 %
Gold	0·23 oz.	0·07 oz.	Trace
Silver	142·80 oz.	14·50 oz.	1·68 oz.

Figuring on 70 per cent of the values in middlings being recovered on being returned to the circuit in actual practice, we have a recovery of practically all the lead, copper, and gold values, and a recovery of 83·28 per cent of the silver values.

Run No. 2.—The same oil mixture and reagents used, only the NaOH solution was added after mixing in pebble mill.

—	Concentrates.	Middlings.	Tailings.
Weight	77 grams	62 grams	861 grams
Analysis—Lead	8·17 %	0·19 %	Trace
Copper	2·75 %	0·08 %	Trace
Iron	3·95 %	1·18 %	0·49 %
Gold	0·20 oz.	0·06 oz.	Trace
Silver	126·68 oz.	12·84 oz.	3·04 oz.

Figuring on 70 per cent of the values in middlings being recovered on being returned to the circuit in actual practice, we have a recovery of practically all the lead, copper, and gold values, and a recovery of 78·33 per cent of the silver values.

Run No. 3.—1,000 grams of the ore put in a pebble mill, to which were added 1·5 c.c. of oil mixture, 40 per cent No. 22 G.N.S., and 60 per cent No. 26 F.P.L., and 4 c.c. of NaOH solution as a deflocculant, and the whole mixed with 2,000 grams of water for seven minutes.

—	Concentrates.	Middlings.	Tailings.
Weight	131 grams	43 grams	826 grams
Analysis—Gold	0·10 oz.	0·06 oz.	Trace
Silver	80·57 oz.	11·10 oz.	3·13 oz.

This test was run much longer than the former ones, to see if it were not possible to clean up the tailings, hence the low grade concentrate. Only the gold and silver were determined in the products. Figuring on a 70 per cent recovery of the values in the middlings, almost all the gold values would be recovered, and 81·90 per cent of the silver values.

Run No. 4.—The same oil mixture and reagents used as in Run No. 3. The test was not carried so far.

——	Concentrates.	Middlings.	Tailings.
Weight	61 grams	81 grams	858 grams
Analysis—Lead	9·14 %	0·06 %	Trace
Copper	2·67 %	0·11 %	Trace
Iron	3·30 %	0·68 %	0·50 %
Gold	0·25 oz.	0·04 oz.	Trace
Silver	150·23 oz.	4·72 oz.	3·28 oz.

Figuring on 70 per cent of the values in the middlings being recovered, we have a recovery of practically all the lead, copper, and gold values, and a recovery of 70·87 per cent of the silver values.

Run No. 5.—The oil mixture used on this test was one pound per ton of 50 per cent coal tar, 40 per cent coal tar creosote, and 10 per cent No. 5 pine oil.

——	Concentrates.	Middlings.	Tailings.
Weight	6 grams	21 grams	468 grams
Analysis—Gold	0·06 oz.	0·023 oz.	Trace
Silver	316·20 oz.	91·73 oz.	5·09 oz.

This test was run on 495 grams of the ore. Combining middling and concentrate, we have a product giving an assay of 145·32 ounces silver, with a recovery of 62 per cent of the silver values in the ore, and practically all the gold values.

Summary.—This is an ore which requires extensive test work to determine the better method of treatment. Our flotation tests, so far, do not show sufficient recovery of the silver values on this low grade of ore to be treated. It is quite probable that we have not ground the ore fine enough, and again we may not have found the better mixture of oils to use.

We are installing a laboratory type, "Holt-Deru" chloridizing-leaching test roaster, in which tests could be conducted to chloridize the raw ore or the concentrates from flotation.

Test No. 67.

NEW ROSS MANGANESE ORE.

Received one carload in three lots on October 12, 1917.

Submitted by the Rossville Manganese Co., Halifax, N.S., through the Munition Resources Commission, Ottawa, Ont.

Lot D.—74 barrels, one barrel of which was used for trial test.

Lot A.—31 barrels.

Lot O.—22 barrels.

Each lot was run separately, a moisture sample was taken, and the sample for analysis was cut out by a Vezin sampler during the run, and reduced down by further crushing and sampling in rolls and small Jones sampler.

The weights and analysis of the above lots were as follows:—

Lot D	73 barrels.
Wet weight	31,675·5 pounds.
Moisture	20·07 per cent.
Dry weight	25,318 pounds.
Analysis—Mn	8·81 per cent.
Fe	8·19 "
Content—Mn	2,229·63 pounds.
Fe	2,073·50 "
Lot A	31 barrels.
Wet weight	13,484 pounds.
Moisture	8·82 per cent.
Dry weight	10,406·5 pounds.
Analysis—Mn	24·71 per cent.
Fe	9·21 "
Content—Mn	3,037·97 pounds.
Fe	1,132·32 "
Lot O	22 barrels.
Wet weight	9,265 pounds.
Moisture	6·06 per cent.
Dry weight	8,703·5 pounds.
Analysis—Mn	29·56 per cent.
Fe	10·59 "
Content—Mn	2,572·75 pounds.
Fe	921·65 "

The product desired was a commercial manganese concentrate, high in manganese, low in iron and silica, suitable for reduction into ferro-manganese in the blast or electric furnace.

The method of crushing and concentration adopted was as follows:—

The crude ore was crushed in a jaw crusher, and fed automatically by a push feeder from a storage bin to an elevator which delivered it through a Vezin sampler and a chute to a Hardinge ball mill. The discharge of the ball mill flowed through a launder to a pump which delivered the pulp on to a callow screen frame fitted with a 24-mesh ton cap screen; the oversize from the screen returning to the mill, and the undersize to a Launder classifier. From the Launder classifier the sands were run onto an Overstrom table, and the slimes to a callow tank, where they were thickened for concentration on a Deister slime table.

The middlings from these tables were returned to the ball mill circuit as they were made.

The concentrates obtained were dried and sampled, giving the following weights and analysis:—

LOT D.

Deister Concentrates—	
Weight	445 pounds.
Analysis—Mn	26·08 per cent.
Fe	22·83 "
SiO_2	20·12 "
P	0·195 "
S	0·05 "
Content—Mn	116·056 pounds.
Fe	101·5935 "
Overstrom Concentrates—	
Weight	2,013 pounds.
Analysis—Mn	27·32 per cent.
Fe	28·62 "
SiO_2	9·77 "
P	0·256 "
S	Trace.
Content—Mn	549·9516 pounds.
Fe	576·1206 "

LOT A.

Deister Concentrates—

Weight	574 pounds.
Analysis—Mn	39·98 per cent.
Fe	15·75 "
SiO_2	7·23 "
P	0·094 "
S	Trace.
Content—Mn	229·4852 pounds.
Fe	90·405 "

Overstrom Concentrates—

Weight	1,314 pounds.
Analysis—Mn	38·48 per cent.
Fe	19·11 "
SiO_2	4·34 "
P	0·125 "
S	Trace.
Content—Mn	505·6272 pounds.
Fe	251·1054 "

LOT O.

Deister Concentrates—

Weight	620 pounds.
Analysis—Mn	41·11 per cent.
Fe	15·50 "
SiO_2	6·12 "
P	0·132 "
S	Trace.
Content—Mn	254·882 pounds.
Fe	96·10 "

Overstrom Concentrates—

Weight	1,182 pounds.
Analysis—Mn	38·39 per cent.
Fe	19·02 "
SiO 2	4·00 "
P	0·093 "
S	Trace
Content—Mn	453·7698 pounds.
Fe	234·8164 "

SUMMARY.

Lot D.	Weights.	Mn	Fe	Mn	Fe
Heads	25,318·0	8·81	8·19	2,229·63	2,073·50
Concentrates	2,458·0	27·10	27·56	666·01	667·61
Tailings	22,860·0	6·84	6·15	1,563·62	1,405·89

Recovery of Mn values in concentrates—29·87 %

Lot A.	Weights.	Mn	Fe	Mn	Fe
Heads	12,294·5	21·07	9·31	2,590·59	1,144·89
Concentrates	1,888·0	38·94	18·09	735·11	341·51
Tailings	10,406·5	17·83	7·72	1,855·48	803·38

Recovery of Mn values in concentrates—28·38%.

Lot O.	Weights.	Mn	Fe	Mn	Fe
Heads	8,703·5	26·99	11·04	2,349·14	960·69
Concentrates	1,802·0	39·32	17·81	708·65	320·92
Tailings	6,901·5	23·77	9·27	1,640·49	639·77

Recovery of Mn values in concentrates—30·17%.

It will be noted from the above results, that a very low recovery, namely 30 per cent of the manganese values was obtained, and that the iron content increases with the manganese. Finer grinding would not alter this condition to any appreciable extent; and while it would possibly increase the grade of the concentrate, the slime loss would be greater, which would lower the recovery.

Test No. 68.

A 50-pound sample of molybdenite ore was received on November 26, 1917, from Robert Gamble, Kakabeka Falls, Ont.

This sample gave the following analysis:—

Molybdenite (MoS_2)	2·46 per cent.
Copper (Cu)	None.
Bismuth (Bi)	None.
Arsenic (As)	None.

The ore was of the amorphous variety, filling the fractures in the quartz. A small amount of pyrite is present.

Tests were conducted on the small callow testing machine on 1,000 gram lots.

RUN No. 1.

Ore crushed to 50 mesh.
Oil used—1½ pounds coal oil per ton.
½ pound No. 75 Crude turpentine per ton.

Concentrates—	
Weight	33 grams.
Analysis	60·97 per cent MoS_2
Content	20·12 grams MoS_2
Recovery	67·60 per cent.
Middlings—	
Weight	38 grams.
Analysis	9·17 per cent MoS_2
Content	3·48 grams MoS_2
Percentage of MoS_2 in crude	11·6 per cent.
Tailings—	
Weight	929 grams.
Analysis	0·675 per cent MoS_2
Content	6·27 grams MoS_2
Loss	20·8 per cent.

Figuring on recovery of 70 per cent of values in middlings the recovery of MoS_2 values in the crude would be 75·7 per cent.

RUN No. 2.

Ore crushed to 80 mesh.
Oil used—3 pounds coal oil per ton.
1 pound No. 75 Crude turpentine per ton.

Concentrates—	
Weight	41 grams.
Analysis	52·44 per cent MoS_2
Content	21·50 grams MoS_2
Recovery	73·1 per cent.

Middlings—

Weight	40 grams.
Analysis	10·19 per cent MoS_2
Content	4·07 grams MoS_2
Percentage MoS_2 in crude	13·8 per cent.

Tailings—

Weight	919 grams.
Analysis	0·42 per cent MoS_2
Content	3·86 grams MoS_2
Loss	13·1 per cent.

Figuring on recovery 70 per cent of values in the middlings, the recovery of MoS_2 values in the crude would be 82·8 per cent.

RUN No. 3.

Ore crushed to 80 mesh.
Oil used—3 pounds coal oil per ton.
1 pound No. 5 Pine oil per ton.

Concentrates—

Weight	40 grams.
Analysis	58·87 per cent MoS_2
Content	23·55 grams MoS_2
Recovery	76·59 per cent.

Middlings—

Weight	97 grams.
Analysis	4·93 per cent MoS_2
Content	4·78 grams MoS_2
Percentage MoS_2 of crude	15·54 per cent.

Tailings—

Weight	863 grams.
Analysis	0·28 per cent MoS_2
Content	2·42 grams MoS_2
Loss	7·87 per cent.

Figuring on a recovery of 70 per cent of values in middlings, the recovery of MoS_2 values in the crude would be 87·46 per cent.

Conclusions.—The ore will have to be ground to at least 80 mesh and possibly a little finer would give better results.

The tailings on the last two runs are fairly low considering the high grade of the milling ore. On an ore around 1 per cent MoS_2 the tailings would be proportionately lower.

It has been found also that better results are obtained in practice on the large machines.

The concentrates are below marketable quality but in practice these are screened to take out the fine iron and slime which is returned to the circuit and the grade of the concentrate in this way increased to marketable quality.

Although this ore is not as easily and as readily concentrated as some of the fine flake varieties there is no doubt that an 85 per cent to 90 per cent recovery can be made by the flotation process and a marketable concentrate produced quite readily.

Test No. 69.

A carload of slag from the Tivani Electric Steel Co., was received on October 26, 27, and 29, 1917.

It consisted of several barrels of wet slag, and the remainder of dry slag, which were mixed in order to prevent the crusher, elevators, and feeders from blocking on the wet slag alone.

The test was made to recover the ferro-molybdenum from the slag, which was supposed to be there in the form of small pellets. It was found, however, that although

some pellets, the size of beans and smaller, were dispersed through the slag, that the greater amount of the ferro-values were there very finely disseminated through it.

PRELIMINARY TEST.

A small test was made on a sample taken from the dry slag, and the crushing watched carefully, to determine the fineness to which it would have to be crushed to obtain a concentration on tables. It was crushed in a small jaw crusher and small rolls, and screened on 20-mesh screen. No free ferro was noticed remaining on the screen. It was then crushed to 30 mesh in rolls, with the same results. It was then crushed to 40 mesh. A few small pieces of ferro and flake molybdenite were caught on the screen. Crushing to 50 mesh, a little more ferro and flake remained on the screen. Weight of flake and ferro remaining on 50-mesh screen – 0·3 grams. Weight of ground slag through 50-mesh screen, 4090 grams.

The material through 50 mesh was run over a small Wilfley table, and the following products obtained:—

Concentrates—	
Weight	76 grams.
Analysis	54·18 per cent Mo.
Middlings—	
Weight	200 grams.
Analysis	2·46 per cent Mo.
Tailings—	
Weight	3,814 grams.
Analysis	1·09 per cent Mo.

Analysis of slag taken for this test, calculated from products, obtained —2·14 per cent Mo.

This sample was not representative of the total shipment, but was merely run to obtain some idea as to the degree of fineness necessary, and the grade of ferro that could be expected from the large run.

FINAL TEST.

The method of procedure on the large scale test was as follows:—

It was first crushed in the jaw crusher, and fed through a Vezin automatic sampler to the Hardinge mill. From the mill the ground pulp was pumped to a callow screen, fitted with an 80-mesh screen, the oversize returned to the mill, and the undersize to a Launder classifier, the sands going direct to the sand table and the slimes to a callow cone, and there thickened for the slime table. The middlings from the tables were returned to the mill, and the tailings sampled every 15 minutes by cutting the full stream into a tailing tank for that purpose.

In the final clean up of the Hardinge mill, the coarse material was screened out, and the iron extracted by a magnet from the ferro, while the fines were run over the table. The middlings were held for analysis.

The results obtained from the run were as follows:—

Wet weight of slag received	34,570·5 pounds.
Moisture	15·09 per cent.
Dry weight of slag	29,354 pounds.
Analysis	5·46 per cent Mo.
Content	1,602·7284 pounds Mo.
Table Concentrates obtained	1,194 pounds.
Calculated analysis	49·10 per cent Mo.
Content	586·161 pounds Mo.
Table Middlings held	350 pounds.
Analysis	20·20 per cent Mo.
Content	70·70 pounds Mo.
Ferro obtained from clean-up of ball mill—	
Weight	45 pounds.

Analysis	73·23 per cent Mo. 2·27 per cent C. 0·181 per cent S.
Content	32·9535 pounds Mo.
Table Tailings—	
Weight	27,765 pounds.
Analysis	1·57 per cent Mo.
Content	435·9105 pounds Mo.

The table concentrates were run over a magnetic separator to remove the metallic iron from the crushing operations which reported with the concentrates.

These two products were weighed and sampled, and gave the following:—

Non-Magnetic—	
Weight	516 pounds.
Analysis	69·15 per cent Mo. 2·08 per cent C. 3·43 per cent S.
Content	356·814 pounds Mo.
Magnetic Iron Product—	
Weight	678 pounds.
Analysis	33·65 per cent Mo. 59·15 per cent Fe.
Content	229·347 pounds Mo.

A summary of the products is as follows:—

Product.	Weight — Lb.	Analysis — Mo.	Content — Mo.	Recovery and Loss. %
High grade ferro	45	73·23	32·9535	2·06
Non-magnetic	516	69·15	356·8140	22·26
Magnetic iron	678	33·65	229·3470	14·31
Middlings	350	20·20	70·7000	4·41
Tailings	27,765	1·57	435·9105	27·20
Totals	29,354	3·84	1,125·7250	
Lost in solution	29,354	0·15	45·0310	2·81
Lost as flocculent MoO_3		0·42	123·2868	7·69
Fine flake and milling loss		1·05	308·6856	19·26
Total		5·46	1,602·7284	100·00

On examination of the head sample, it was found that the molybdenum values were contained in the slag in all forms, from the sulphide to the ferro-molybdenum; 0·15 per cent Mo was found to be soluble probably there as MoO_3 or MoS_3; 0·42 per cent Mo was found to be insoluble other than ferro-molybdenum and molybdenite probably there as Mo_2O_3. This would have a tendency to float off as flocculent slime. Besides this, there is no doubt but that considerable fine flake was lost, which would not show in the tailing sample. Also, we have found that some fine ferro still remained in the circuit, behind the lining in the Hardinge mill and in the pump lining. We found that a small amount of ferro kept reporting on the table during our next run on a carload of chromite.

Conclusions.—A higher recovery and better concentration could have been made by first crushing to 10 mesh and screening on 30 mesh, jigging the oversize, —10+30; regrinding the tailings with the –30 size and concentrating on tables.

Whatever method of concentration is used—unless it is some elaborate system to recover the soluble and the values floating off in slimes, so as to obtain a separation of the molybdenum values in its various forms in the slag—a high loss is bound to occur.

It has been determined that by crushing as fine as 80 mesh, the ferro is not all freed, hence the high tailing analysis in the above test.

A good recovery of the flake molybdenite in the slag could not be expected by flotation, as the physical character of the flake has been changed.

To obtain a high recovery of the molybdenum values in the slag, would necessarily mean research work, in separating the various forms in which the molybdenum values are contained in the slag.

Test No. 70.

CHROME ORE.

A small shipment of three bags of chrome ore was received from the Dominion Mines and Quarries, Ltd., Black Lake, Quebec.

Weight received	236·5 pounds.
Analysis	13·16 per cent Cr_2O_3
Content	31·12 pounds Cr_2O_3

This ore represented the low grade that is being discarded from their shipping ore from one of their pits.

A concentration test was made to determine the grade of concentrates that could be expected and the possible recovery of the chromite values.

The ore was crushed to 30 mesh and run over the Overstrom table.

Concentrates received	43·5 pounds.
Analysis	42·53 per cent Cr_2O_3
Content	18·50 pounds Cr_2O_3
Recovery	59·45 per cent.
Middlings obtained	21·5 pounds.
Analysis	24·61 per cent Cr_2O_3
Content	5·29 pounds Cr_2O_3
Per cent of Cr_2O_3 values	17·00 per cent.
Tailings obtained	118·0 pounds.
Analysis	2·94 per cent Cr_2O_3
Content	3·47 pounds Cr_2O_3
Loss Cr_2O_3 values	11·15 per cent.
Slime loss	53·5 pounds.
Calculated analysis	7·21 per cent Cr_2O_3
Content	3·86 pounds Cr_2O_3
Loss Cr_2O_3 values	12·40 per cent.

SUMMARY.

In actual practice, the middlings would be returned to the circuit. From the above class of ore a concentrate would be expected giving an analysis of 42·50 per cent Cr_2O_3, with a recovery of the Cr_2O_3 values of 70 per cent.

Test No. 71.

CHROME ORE.

A small shipment of two bags of chrome ore and one bag of concentrates was received from the Mutual Chemical Co., Black Lake, Que.

Weight of ore received	158·5 pounds.
Analysis	20·55 per cent Cr_2O_3
Content	32·57 pounds Cr_2O_3

A concentration test was made on this ore to determine the grade of concentrates that could be obtained and the recovery of chromite values that could be expected.

The ore was crushed to pass a 30-mesh screen ·0198 aperture and run over an Overstrom sand table.

Concentrates obtained	42·5 pounds.
Analysis	47·18 per cent Cr_2O_3
Content	20·05 pounds Cr_2O_3
Recovery	61·56 per cent.
Middlings obtained	20·0 pounds.
Analysis	30·52 per cent Cr_2O_3
Content	6·10 pounds Cr_2O_3
Per cent Cr_2O_3 values	18·73 per cent.
Tailings obtained	62·5 pounds.
Analysis	3·66 per cent Cr_2O_3
Content	2·29 pounds Cr_2O_3
Loss Cr_2O_3 values	7·03 per cent.
Slime loss	33·5 pounds.
Calculated analysis	12·33 per cent Cr_2O_3
Content	4·13 pounds Cr_2O_3
Loss Cr_2O_3 values	12·68 per cent.
Combined concentrates and middlings	62·5 pounds.
Calculated analysis	41·84 per cent Cr_2O_3
Content	26·15 pounds Cr_2O_3
Recovery Cr_2O_3 values	80·29 per cent.

Summary.—In actual practice the middlings would be returned to the circuit. It would therefore be possible to obtain from this grade of ore, concentrates of grade 47 to 48 per cent, with a recovery of from 75 per cent to 80 per cent of the chromite values, or a concentrate of grade 42 per cent with a recovery of from 80 to 85 per cent of the Cr_2O_3 values.

No work has been done on the bag of concentrates, but a test was made on similar concentrates to raise the grade by magnetic concentration, with the result that the high grade magnesium chrome went with the gangue into the tailing, and the lower grade iron chrome went into the concentrates, giving two products which gave an analysis of practically the same in Cr_2O_3 values.

Further work by other methods will be attempted later, in raising the grade of the concentrates, and also in recovering the Cr_2O_3 values in the slime loss.

Test No. 72.

SMALL SCALE CONCENTRATION TESTS ON CHROME ORE FROM QUEBEC ASBESTOS AND CHROME COMPANY, ST. CYR, QUE.

A shipment of three lots, of two bags each, of chrome ore, was received from Douglas B. Sterrett, manager, Quebec Asbestos and Chrome Company, St. Cyr, Quebec.

These three different lots were shipped as representing the three chief varieties of concentrating ore found on the property, and were designated "A" "B" and "C". On examination they were found to be slightly different, varying in crystallization and the amount of asbestos fibre in the gangue. All three samples represented a cleaner variety of ore than the typical chrome ores of the vicinity.

Analysis of Lot A	19·71 per cent Cr_2O_3
" " B	18·00 per cent Cr_2O_3
" " C	26·28 per cent Cr_2O_3

The tests were conducted to obtain, if possible, a 50 per cent Cr_2O_3 product, and if this were not possible, what commercial product could be obtained with the highest possible recovery of the chromite values.

A small sample of each of the lots was taken, and crushed to 20 mesh. These were sized on 30, 40 and 50 mesh, and examined under the microscope to ascertain at what point the mineral was free. It was found that on 30 mesh a large proportion of the mineral particles were not free; this proportion diminishing the finer the size. This proved also that the ore would have to be crushed to at least 20 mesh for concentration, and that better results could be looked for by even finer crushing.

It was decided to proceed by crushing portions of the lots to pass through 20, 30, and 40 mesh, and by concentrating the unsized material on a table concentrator, the following results were obtained:—

"LOT A."

A portion of the lot was crushed to pass a 20-mesh screen, ·034-inch aperture, and concentrated on an Overstrom table.

Weight of crude ore..	70 pounds.
Analysis..	19·71 per cent Cr_2O_3
Content..	13·80 pounds.
Concentrates obtained..	15·0 "
Analysis..	43·62 per cent Cr_2O_3
Content..	6·54 pounds.
Recovery of Cr_2O_3 values..	47·4 per cent.
Middlings obtained..	16·5 pounds.
Analysis..	30·73 per cent Cr_2O_3
Content..	5·07 pounds.
Per cent of total Cr_2O_3 in crude..	36·7 per cent.
Tailings obtained..	28·0 pounds.
Analysis..	3·79 per cent Cr_2O_3
Content..	1·06 pounds.
Loss of Cr_2O_3 values..	7·70 per cent.
Slime loss..	10·5 pounds.
Analysis (calculated)..	11·30 per cent Cr_2O_3
Content..	1·13 pounds.
Loss of Cr_2O_3 values..	8·19 per cent.
Combined concentrates and middlings..	31·5 pounds.
Calculated analysis..	36·9 per cent Cr_2O_3
Content..	11·61 per cent Cr_2O_3
Total recovery..	84·1 per cent.

Another portion of the lot was crushed to pass a 30-mesh screen, ·0198 aperture, and concentrated on an Overstrom table.

Weight of crude ore..	70 pounds.
Analysis..	19·71 per cent Cr_2O_3
Content..	13·80 pounds.
Concentrates obtained..	15·50 "
Analysis..	48·61 per cent Cr_2O_3
Content..	7·53 pounds.
Recovery of Cr_2O_3 values..	54·6 per cent.
Middlings obtained..	16·0 pounds.
Analysis..	33·30 per cent Cr_2O_3
Content..	5·33 pounds.
Per cent of total Cr_2O_3 in crude..	38·6 per cent.
Tailings obtained..	23·5 pounds.
Analysis..	2·56 per cent Cr_2O_3
Content..	0·60 pounds.
Loss of Cr_2O_3 values..	4·3 per cent.
Slime loss—weight...	15·0 pounds.
Analysis (calculated)..	2·26 per cent Cr_2O_3
Content..	0·34 pounds.
Loss of Cr_2O_3 values..	2·5 per cent.
Combined concentrates and middlings..	31·5 pounds.
Calculated analysis..	40·80 per cent Cr_2O_3
Content..	12·86 pounds.
Recovery of Cr_2O_3..	93·2 per cent.

"LOT B."

A portion of the lot was crushed to pass a 20-mesh screen, ·034 aperture, and concentrated on an Overstrom table.

Weight of crude ore..	73 pounds.
Analysis..	18·00 per cent Cr_2O_3
Content..	13·15 pounds.
Concentrates obtained..	18·25 "
Analysis..	44·29 per cent Cr_2O_3

Content..	8·08 pounds.
Recovery of Cr_2O_3 values..	61·40 per cent.
Middlings obtained..	13·25 pounds.
Analysis..	19·50 per cent Cr_2O_3
Content..	2·58 pounds.
Per cent of total Cr_2O_3 in crude..	19·62 per cent.
Tailings obtained..	31·25 pounds.
Analysis..	2·52 per cent Cr_2O_3
Content..	0·79 pounds.
Loss of Cr_2O_3..	6·00 per cent.
Slime loss—weight...	10·25 pounds.
Analysis (calculated)..	16·6 per cent Cr_2O_3
Content..	1·70 pounds.
Loss of Cr_2O_3 values..	12·90 per cent.
Combined concentrates and middlings..	31·50 pounds.
Calculated analysis..	33·8 per cent Cr_2O_3
Content..	10·66 pounds.
Recovery of Cr_2O_3 values..	81·06 per cent.

The products from the above test were mixed together, and crushed to pass a 30-mesh screen, ·0198-inch aperture, and a new head sample was taken to represent the lot. The unsized material was concentrated on the Overstrom table.

Weight of crude ore..	60 pounds.
Analysis..	18·93 per cent Cr_2O_3
Content..	11·36 pounds.
Concentrates obtained..	9·50 "
Analysis..	47·87 per cent Cr_2O_3
Content..	4·55 pounds.
Recovery of Cr_2O_3 values..	40·05 per cent.
Middlings obtained..	17·5 pounds.
Analysis..	30·60 per cent Cr_2O_3
Content..	5·35 pounds.
Per cent of total Cr_2O_3 content of crude..	47·09 per cent.
Tailings obtained..	23·0 pounds.
Analysis..	3·41 per cent Cr_2O_3
Content..	0·78 pounds.
Loss of Cr_2O_3..	6·86 per cent.
Slime loss—weight..	10·00 pounds.
Calculated analysis..	6·8 per cent Cr_2O_3
Content..	0·68 pounds.
Loss of Cr_2O_3 values..	5·98 per cent.
Combined concentrates and middlings..	27·0 pounds.
Calculated analysis..	36·6 per cent Cr_2O_3
Content..	9·90 pounds.
Total recovery..	87·10 per cent.

Another portion of this lot marked B was crushed to pass 40 mesh, and treated unsized on the Overstrom table. This lot was sampled separately.

Weight of crude ore..	81 pounds.
Analysis..	19·06 per cent Cr_2O_3
Content..	15·44 pounds.
Concentrates obtained..	14·0 "
Analysis..	47·3 per cent Cr_2O_3
Content..	6·62 pounds.
Recovery of Cr_2O_3 values..	42·9 per cent.
Middlings obtained..	19·0 pounds.
Analysis..	36·19 per cent Cr_2O_3
Content..	6·88 pounds.
Per cent of total Cr_2O_3 content of crude..	44·5 per cent.
Tailings obtained..	34·5 pounds.
Analysis..	2·05 per cent Cr_2O_3
Content..	0·71 pounds.
Loss of Cr_2O_3..	4·6 per cent.
Slime loss—weight..	13·5 pounds.
Analysis calculated..	9·1 per cent Cr_2O_3
Content..	1·23 pounds.
Loss of Cr_2O_3..	7·9 per cent.
Combined concentrates and middlings..	33·0 pounds.
Analysis calculated..	40·90 per cent Cr_2O_3
Content..	13·5 pounds.
Total recovery..	87·4 per cent.

"LOT C."

The whole of this lot was crushed up and sampled. It was then carefully divided into three separate lots by passing through a Jones sampler.

One portion was crushed to pass a 20-mesh screen, having a ·0340-inch opening, and was treated unsized on the Overstrom table.

Weight of crude ore	91 pounds.
Analysis	26·28 per cent Cr_2O_3
Content	23·91 pounds.
Concentrates obtained	30 pounds.
Analysis	46·20 per cent Cr_2O_3
Content	13·88 pounds.
Recovery of Cr_2O_3	58·10 per cent.
Midd'ings obtained	21 pounds.
Analysis	33·3 per cent Cr_2O_3
Content	7·00 pounds.
Per cent of total Cr_2O_3 content of crude	29·0 per cent.
Tailings obtained	25 pounds.
Analysis	5·36 per cent Cr_2O_3
Content	1·34 pounds.
Loss of Cr_2O_3	5·6 per cent.
Slime loss—weight	15 pounds.
Analysis (calculated)	11·26 per cent Cr_2O_3
Content	1·69 pounds.
Loss of Cr_2O_3	7·07 per cent.
Combined concentrates and middlings	51 pounds.
Calculated analysis	40·9 per cent Cr_2O_3
Content	20·88 pounds.
Total recovery	87·3 per cent.

A second portion of this lot C was crushed to pass a 30-mesh screen, ·0198-inch opening, and was treated unsized on the Overstrom table.

Weight of crude ore	85·5 pounds.
Analysis	26·28 per cent Cr_2O_3
Content	22·47 pounds.
Concentrates obtained	25·50 "
Analysis	51·70 per cent Cr_2O_3
Content	13·18 pounds.
Recovery of Cr_2O_3 values	58·70 per cent.
Middlings obtained	20·50 pounds.
Analysis	37·40 per cent Cr_2O_3
Content	7·67 pounds.
Per cent of total Cr_2O_3 content of crude	34·1 per cent.
Tailings obtained	23·50 pounds.
Analysis	4·04 per cent Cr_2O_3
Content	0·95 pounds.
Loss of Cr_2O_3 values	4·2 per cent.
Slime loss—weight	16·0 pounds.
Analysis (calculated)	4·19 per cent Cr_2O_3
Content	0·67 pounds.
Loss of Cr_2O_3	2·98 per cent.
Combined concentrates and middlings	46·0 pounds.
Calculated analysis	45·1 per cent Cr_2O_3
Content	20·85 pounds.
Total recovery	92·8 per cent.

A third portion of lot C was crushed to pass a 40-mesh screen, ·0150-inch opening, and was treated unsized on the Overstrom table.

Weight of crude ore	70 pounds.
Analysis	26·28 per cent Cr_2O_3
Content	18·40 pounds.
Total content of products	19·27
Concentrates obtained	23·00 pounds.
Analysis	48·35 per cent Cr_2O_3
Content	11·12 pounds.
Recovery of Cr_2O_3	57·7 per cent.
Middlings obtained	21·0 pounds.
Analysis	36·41 per cent Cr_2O_3

Content	7·65 pounds.
Per cent of total Cr_2O_3 content of crude	39·7 per cent.
Tailings obtained	16·50 pounds.
Analysis	3·02 per cent Cr_2O_3
Content	0·50 pounds.
Loss of Cr_2O_3 values, per cent of total content of products	2·60 per cent.
Combined concentrates and middlings	44·00 pounds.
Analysis (calculated)	42·66 per cent Cr_2O_3
Content	18·77 pounds.
Total recovery	97·4 per cent.

SUMMARY AND CONCLUSIONS.

It is evident from the above tests, that the ore should be crushed to pass at least a 30-mesh screen, having a ·0198-inch aperture, and that there is no marked improvement obtained by crushing to 40 or 50 mesh. It would also seem that no advantage would be gained by milling any of the three lots separately.

The middling obtained in the above tests represents what can be called a true middling product, that is to say, it consists of particles of un-freed mineral and gangue. Attempts were made to retreat this product on the table without regrinding, but little or no separation was obtained.

If a high grade chromite concentrate containing 48 per cent—50 per cent Cr_2O_3 is desired, a large proportion of the table product will have to be cut as a middling, and returned to the crushing department for regrinding. The amount of middling returned for regrinding would represent between 20 per cent and 25 per cent of the weight of the original feed to the table, and will contain between 30 per cent and 40 per cent of the total chromite in the feed. In practice, by returning such a large proportion of high grade material, the feed to the table will be considerably enriched, which would doubtless lead to heavier slime losses.

On the other hand, if a concentrate containing 40 per cent to 45 per cent Cr_2O_3 is sufficient, a very high extraction can be expected, ranging around 90 per cent.

Regarding the method of treatment for this ore we would recommend fine grinding to 30-mesh ·0198-inch aperture, in Ball mills or stamps, preferably Ball mills, followed by the concentration of the unsized material on tables.

It is interesting to note that traces of platinum were found in the ore. A portion of the concentrates on the upper end of the table was cut out and assayed for platinum, but only traces were reported.

Test No. 73.

LARGE SCALE CONCENTRATION TESTS ON CHROME ORE FROM QUEBEC ASBESTOS AND CHROME COMPANY, ST. CYR, QUE.

A carload of chrome ore was received on November 8, 1917, from the Quebec Asbestos and Chrome Co., St. Cyr, Que., of which, Douglas B. Sterrett is general manager.

This carload represented the run-of-mine from the various pits on the property, and was a discarded car, supposed to be below the 30 per cent Cr_2O_3 called for, hence it was shipped on to Ottawa for concentration tests.

Wet weight of ore received	67,158 pounds.
Dry weight of ore received	66,769 "
Samples and clean up held	273 "
Dry weight of ore concentrated	66,496 "
Analysis calculated from weights and analyses of each lot	31·38 per cent Cr_2O_3

The carload was divided into two lots. On one lot it was desired that we make a 46 per cent to 48 per cent Cr_2O_3 concentrate; on the other lot a 50 per cent Cr_2O_3

concentrate. The method of procedure is best illustrated by the following flow sheet.

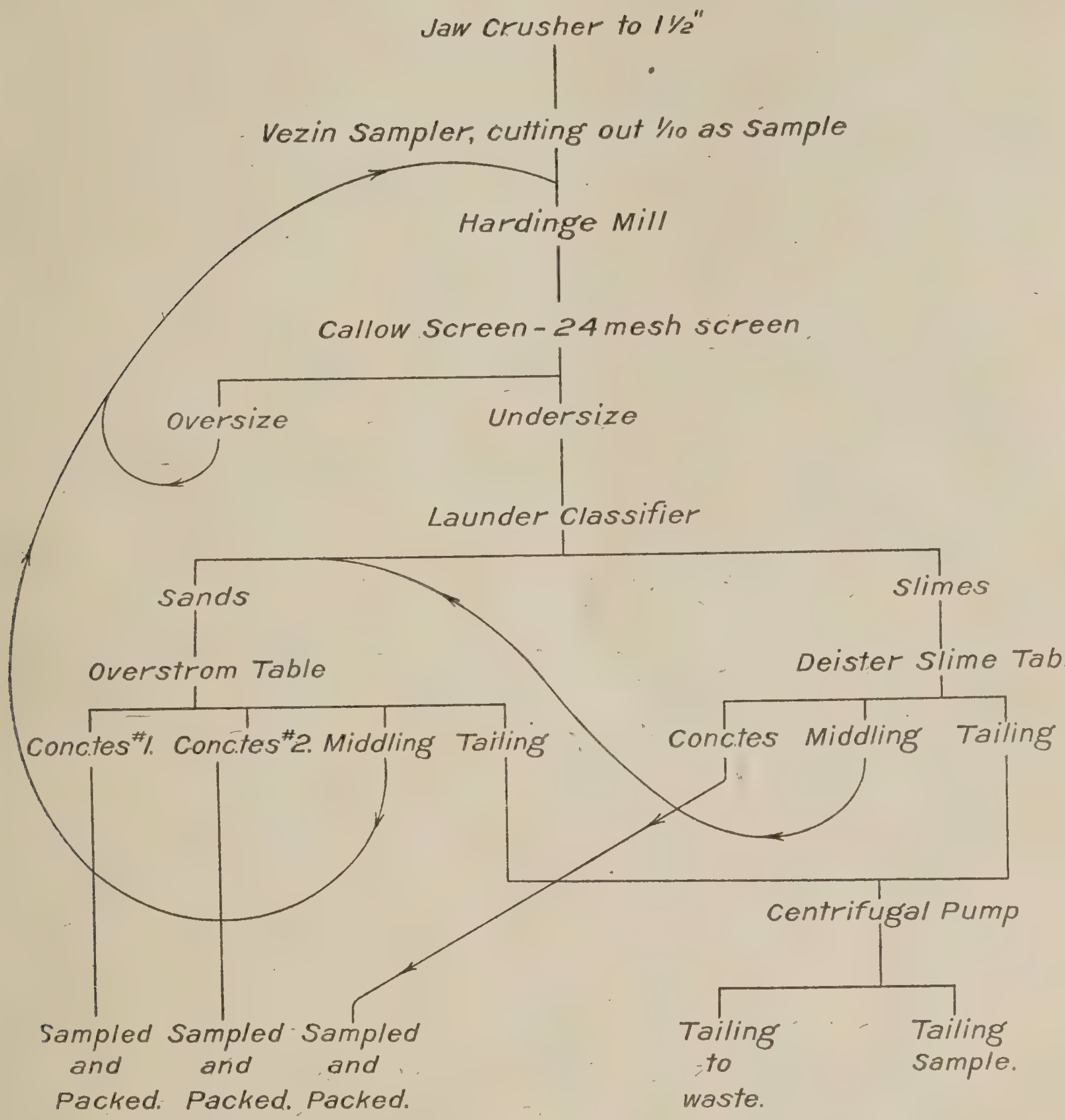


Fig. 3.—Flow sheet, concentration test, Chromite Ore.

In running lot No. 1, only one grade of concentrate was taken off on sand table; in lot No. 2, two grades were taken from the table. Besides this, a small streak was cut out reporting highest up on the table. This streak contained metallic iron from the crushing operations, and will be analysed for platinum, cobalt, nickel, copper, etc.

The tailing sample was cut out every 15 minutes by cutting the full stream from the pump discharge into a tank by means of a three-way valve. In this manner an accurate tailing sample was obtained.

LOT No. 1.

Wet weight	32,529 pounds.
Moisture	0·55 per cent.
Dry weight	32,350 pounds.
Analysis	31·32 per cent Cr_2O_3
Content	10,132·02 pounds Cr_2O_3

Overstrom Concentrates	14 barrels.
Dry weight	13,736 pounds.
Analysis	48·74 per cent Cr_2O_3
Content	6,694·9264 pounds Cr_2O_3
Recovery	66·08 per cent.
Deister Concentrates	3 barrels.
Dry weight	2,682·5 pounds.
Analysis	46·73 per cent Cr_2O_3
Content	1,253·53225 pounds Cr_2O_3
Recovery	12·37 per cent.
Tailings to Waste Dump	
Dry weight	15,931·5 pounds.
Analysis	13·69 per cent Cr_2O_3
Content	2,181·02235 pounds Cr_2O_3
Loss	21·53 per cent.

LOT No. 2.

Wet weight of ore	34,629 pounds.
Less samples and clean up	273·0 "
Wet weight of ore concentrates	34,356 "
Moisture	0·61 per cent.
Dry weight	34,146 pounds.
Analysis	31·43 per cent Cr_2O_3
Content	10,732·0878 pounds Cr_2O_3
Overstrom Concentrates No. 1	9 barrels.
Dry weight	9,105·5 pounds.
Analysis	50·53 per cent Cr_2O_3
Content	4,601·00915 pounds Cr_2O_3
Recovery	42·87 per cent.
Overstrom Concentrates No. 2	7 barrels.
Dry weight	6,605·5 pounds.
Analysis	46·61 per cent Cr_2O_3
Content	3,078·82355 pounds Cr_2O_3
Recovery	28·69 per cent.
Deister Concentrates	3 barrels.
Dry weight	2,137·5 pounds.
Analysis	47·56 per cent Cr_2O_3
Content	1,016·595 pounds Cr_2O_3
Recovery	9·47 per cent.
Tailings to Waste Dump—	
Dry weight	16,297·5 pounds.
Analysis	12·66 per cent Cr_2O_3
Content	2,063·2635 pounds Cr_2O_3
Loss	19·22 per cent.

Conclusions.—In running lot No. 1, only one grade of concentrate was made on the Overstrom table, a large amount of middlings were returned to the circuit; in lot No. 2, two grades of concentrate were made, and only a small amount of middlings were returned to the circuit. The latter gave much better results. Lot No. 2 was run much faster than Lot No. 1, with better results.

These conditions were due to the fact that our milling capacity was much in excess of our concentrating capacity. The chromite was ground too fine in the mill, in other words we obtained a maximum amount of slimes. Had we table capacity equal to our milling capacity much better results would have been obtained.

The main difficulty in concentrating the ore is that the fine chromite slime becomes entangled with the asbestos fibre in the ore, and is lost in the tailings. Very little loss is accounted for in the fine particles floating off. In examining the tailings under the microscope, the above point is very clearly seen. Therefore, in concentrating this ore it is essential that a minimum amount of slime be made, and if possible that the asbestos be removed from the pulp. This can be accomplished, to a certain extent, by putting in a drag classifier after the mill and ahead of the screen, or some other arrangement for freeing the fine chrome particles from the asbestos fibre. This will also assist the wet screening on the callow screen following the classifier, and give an ideal product for the tables. It is a question whether the fine slime from the classifier will pay to treat or not.

Test No. 74.

A carload of grey sandstone was received on December 10, 1917, from the Nepean Sandstone Quarries, Ltd., Ottawa, Ont.

This carload was crushed for the above company for shipment to the glass companies.

It was crushed in the jaw crusher and ball mill fitted with 18-mesh screens.

The stone was moist and blocked the screens badly, hence a low duty was obtained, and consequently much finer crushing was done.

The crushed sandstone was disposed of in the following manner:—

Loaded in C.P. car 204056 for shipment to Dominion Glass Co., Montreal—		
Net wet weight..	61,662·5	pounds.
Shipped to the Humphreys Glass Co., Moncton, N.B., 25 bags—		
Net wet weight..	2,012·0	"
Held for Nepean Sandstone Quarries, Ltd., Ottawa, Ont., 2 bags—		
Net wet weight..	320·0	"
Discarded in cleaning up circuit and final clean up of mill.	2,500·0	"
Fines mixed with snow discarded—		
Net wet weight, approx..	1,500·0	"
Totals..	69,994·5	"

A sample was taken during the crushing operations from the ball mill discharge.

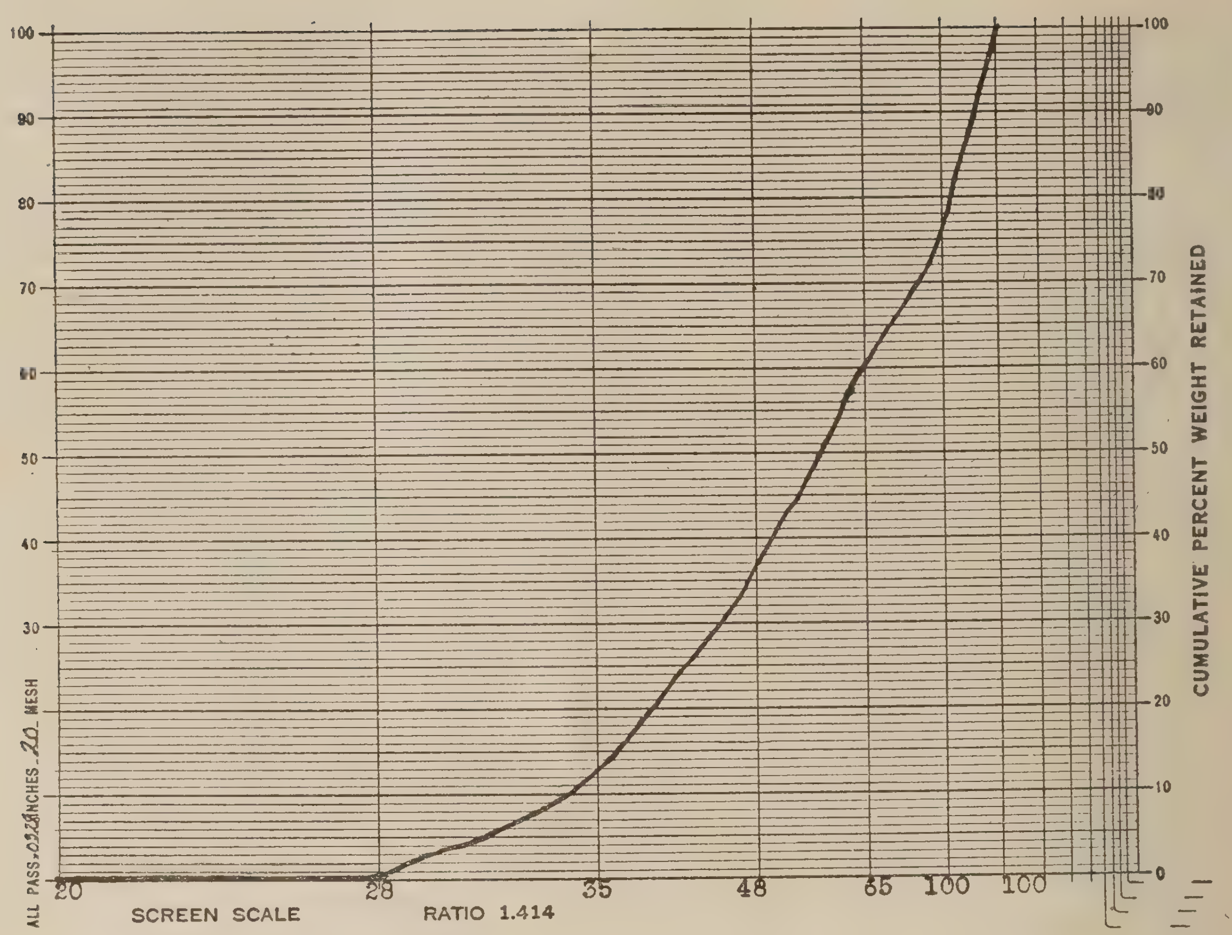
This sample was cut down for moisture, screen test and analysis.

The moisture sample showed the crushed stone to contain 1·62 per cent water.

Attached is copy of screen test data, showing condition of the crushed sandstone.

The analysis of the sample from the carload is as follows:—

Pulp dried at 110° for 2 hours—		
Silica..	98·62	per cent.
Loss in weight on ignition..	1·02	"
Analysis of ignited pulp—		
Silica..	99·64	"
Fe—0·22 per cent or Fe_2O_3..	0·34	"
CaO..	faint trace.	



Indicate the Screen Crushed through and also First Retaining Screen	Screen Scale Ratio 1·414				Sample Weights grams	Per Cent	Per Cent Cumulative Weights
	Openings		Mesh	Diameter Wire Inches			
	Inches	Milli-meters					
	1·050	26·67		·149			
	·742	18·85		·135			
	·525	13·33		·105			
	·371	9·423		·092			
	·263	6·680	3	·070			
	·185	4·699	4	·065			
	·131	3·327	6	·036			
	·093	2·362	8	·032			
	·065	1·651	10	·035			
	·046	1·168	14	·025			
	·0328	·833	20	·0172			
−20+28	·0232	·589	28	·0125	23	0·93	0·93
−28+35	·0164	·417	35	·0122	297	12·09	13·02
−35+48	·0116	·295	48	·0092	602	24·50	37·52
−48+65	·0082	·208	65	·0072	585	23·81	61·33
−65+100	·0058	·147	100	·0042	370	15·06	76·39
Pass 100					580	23·61	23·61
				Totals	2,457	100·00	

Fig. 4.—Cumulative, direct diagram, showing analysis of samples of Nepean Sandstone.

III

REPORT OF THE CHEMICAL LABORATORY.

H. C. MABEE, *Chemist.*

In previous years, the Chemical Laboratory of the Ore Dressing and Metallurgical Division was essentially a plant laboratory, that is to say, it was concerned almost entirely with the analysis of samples produced from concentration tests on ores and other products in the Ore Dressing plant. During the past year, however, this laboratory was almost entirely concerned directly with war work for the Imperial Munitions Board; and indirectly for the Canadian Munition Resources Commission, upon field samples of minerals which are urgently needed for war purposes.

In addition to this, some 275 core samples were received from diamond drilling operations which was conducted on a molybdenite deposit near Quyon, Que.

During the fiscal year 1917, a total of 1,743 samples were received and reported, which involved some 4,819 chemical determinations.

The following list of minerals, ores, metals, etc., will indicate the nature and extent of the work accomplished:—

Material.	Number of Samples.	Material.	Number of Samples.
Molybdenite, ores, etc.	1,163	Silver ores	4
Ferro-molybdenum	132	Copper ores	1
Manganese ores	159	Graphite ores	14
Manganese sinter	4	Coke	1
Tungsten ores	48	Ferro furnace dust	8
Antimony ores	12	Ferro furnace slags	20
Iron ores	17	Tin ores	3
Chromite ores	73	Iron pyrites ores	3
Zinc-lead ores	48	Magnesite	2
Zinc ores	3	Titaniferous ores	4
Lead-copper ores	7	Nickel ores	3
Gold and silver ores	13	Lime (flux)	1

In addition to the foregoing, many samples of various sorts were submitted for qualitative tests, for the purpose of identification.

In March, the chemical laboratory was transferred from the limited quarters which had been provided in the Fuel Testing Station to that portion of an extension to the Ore Dressing and Metallurgical plant which had been set aside and arranged for its accommodation. The total floor area allotted for this purpose consists of 650 square feet, of which 460 square feet are occupied by the main laboratory, and the remainder is taken up by balance room and office.

With these improved working conditions the present requirements appeared to be quite fully met; but the steady increase in the demands upon this laboratory have been such, that all available space, both as regards accommodation for chemists and also that required for additional apparatus, is now at its full capacity.

Mention might be made also of the very urgent need of better assay laboratory accommodation. This work has been conducted in a small room located in the basement of the Fuel Testing Station, but owing to additional work which has been undertaken by the staff of the Fuels and Fuel Testing Division, it became necessary

to occupy the greater part of this room for that purpose. This arrangement necessarily means much inconvenience, and often much delay in getting out assay results as promptly as required.

The equipment of the laboratory has been increased by the following pieces of apparatus:—

A Hoskins electric combustion furnace, type FB No. 301, for carbon determinations in steels and ferro-alloys, a 10-ampere rheostat and a 1KW 60-cycle transformer for the above furnace. A complete electrolytic apparatus for electro chemical analysis, including 10 Edison storage cells, type B 6, two double range ammeters, and one voltmeter of the portable type, also two supports for electrodes. The arrangement of this special piece of electrical apparatus was designed, and for the most part, constructed on the premises, and is such that two different determinations, with different voltage, if necessary, can be made at the same time; the connexions being so arranged that the current from one, two, or any number of cells up to ten, may be drawn off from either of the two outlets on the table. In addition to the above, an electric muffle furnace has been installed, a Barnstead automatic water still, type L, a Crowell pressure and vacuum pump to provide suction for filtering purposes, and a 24-inch electrically driven fan connected with the draught-cupboard for ventilating purposes.

With these improved conditions and increased facilities at our disposal, this laboratory was placed in a much better position to undertake and accomplish more valuable work in 1917 than in any previous year.

CERAMIC DIVISION.

I

INVESTIGATION OF CLAY AND SHALE RESOURCES.

J. Keele, *Chief of Division.*

INTRODUCTORY.

During the greater part of the year 1917 my attention was given to the examination and testing of various raw materials in the laboratory; in writing individual reports on results of tests, and in technical correspondence relating to the Ceramic industry in general, in answer to numerous inquiries for information.

A short time was taken during the summer months to examine clay deposits in eastern Ontario, and to collect samples for testing. The examination of this region, so far, has not resulted in the discovery of any high grade clays. In northern Ontario, however, samples of very fine clays have been received from prospectors; but the deposits located are rather too far from railway lines to be available at present.

There has been a considerable falling off in the demand for information regarding clays and shales suitable for the manufacture of structural wares, owing to the greatly reduced amount of building operations undertaken during recent years. On the other hand, there is a much greater demand for information regarding high grade clays, such as those suitable for metallurgical purposes and for the paper trade. A considerable amount of laboratory work was also done on magnesite and silica rock for refractory purposes.

Mr. N. B. Davis, assistant ceramic engineer, resigned his position in May, and has not been replaced since, owing to the difficulty in obtaining men trained in this branch of technology.

The report of Mr. Davis on the Clay Deposits of Southern Saskatchewan has been published. This report covers, in detail, one of the most important clay areas in the Dominion.

The following notes are a summary of the results of laboratory and field work done during the past year. A full report on the clays of eastern and northern Ontario will be prepared when the field information is complete.

NOVA SCOTIA.

The clay and shale deposits of Nova Scotia have been examined in the field and laboratory, and are the subject of a former report which has been widely distributed. Since then, further examination, and mining operations in the coal districts, have revealed the presence of shales or clays hitherto unnoticed.

Westville.—The manufacture of brick used in metallurgical processes has been carried on for several years at Westville. The material for this purpose is a hard, dark grey shale, found under the No. 3 coal seam at the Drummond colliery.

Recently, a sample of shale, which occurs below the main seam at this colliery, was sent to the Mines Branch laboratory for examination.

This material, Lab. No. 585, is a hard, light grey shale, which, when ground to pass a 16-mesh screen, and mixed with water, develops a high plasticity, with fine working qualities. It dries readily after moulding, with a drying shrinkage of 5 per cent.

Its behaviour on burning is as follows:—

Cone.	Absorption.	Fire Shrinkage.	Colour.
	%	%	
010	14·0	0	Buff.
03	5·0	1	"
3	2·5	2	"
15	Fused.		

This shale burns to a good dense body, even at the lower temperatures, and would be suitable for the various grades of high class structural materials. When finely ground, it develops a high plasticity, and can be moulded or modelled into any desired form; so that it could probably be used in the manufacture of architectural terra-cotta.

It is not refractory enough to be classed as a fireclay, but when coarsely ground it could be made into brick for the same uses to which the shale under No. 3 seam is adapted, viz., linings for ladles in the open-hearth steel process. Compared with the latter clay, it is more plastic and has a slightly greater shrinkage. Owing to its good plasticity it is better adapted for making special intricate shapes for furnace fittings, for use where it would not be subjected to a very high temperature; but will withstand as high a temperature as the shale now in use. These two shales are the most refractory materials so far found in the coal measures in Nova Scotia, with the exception of one bed over a coal seam at Inverness. The clay at Inverness is of the fine-grained type known as stoneware clay, and is refractory enough to be classed as a third grade fireclay.

Morien, C.B.—A sample of brown shale from the Millstone grit formation on the western shore of South Head near Morien was collected by A. O. Hayes of the Geological Survey. The sample (Lab. No. 622) taken from the weathered outcrop had good plasticity and working qualities, and a drying shrinkage of about 6 per cent. Its behaviour on burning was as follows:—

Cone.	Absorption.	Fire Shrinkage.	Colour
	%	%	
06	10·8	2	Pink-buff.
03	3·5	4	Dark buff.
3	2·9	4	"
9	Softens and deforms.		

This clay burns to a hard dense body of good buff colour, and is suitable for the manufacture of face brick made by both the stiff-mud and dry-press process, or for making hollow building blocks. The fresh hard shale below the weathered portion would probably be suitable for vitrified paving blocks.

Neils Harbour, C.B.—Residual clay exposed on road to Ingonish, about 2 miles south of Neils Harbour. This material which was sampled by A. O. Hayes, is apparently derived from granitic rocks by weathering. It contains a large amount of quartz and mica grains, and is only feebly plastic when wet, so that it is difficult to mould into shape. The softening point was determined to be about cone 20 (2786 deg. F.), so that it is not quite refractory enough to be classed as a fireclay. If the material were washed so as to eliminate the rock particles, a fairly high grade clay might be obtained, but as the amount available does not appear to be large, this operation would not be economical.

CLAY MINING.

Musquodoboit.—The pottery clays that occur on Murphy brook at Middle Musquodoboit have been mined during the past 2 years and shipped to Jas. W. Foley & Company of St. John, N.B., for making stoneware pottery.

The clay in this locality consists of white, grey, and red clays, with some interbedded white and red sands. The white clay is a third class fireclay and the red clay is semi-refractory, both are of the stoneware type. When these deposits were examined by the writer in 1909, there were no railroad facilities, and consequently they were not worked.

The Nova Scotia Steel and Coal Company have begun mining the fireclay deposits at Shubenacadie on the Intercolonial railway line. This clay is shipped to Sydney Mines and used for the manufacture of coke oven brick.

NEW BRUNSWICK.

GRAND LAKE COAL DISTRICT.

The large area of Carboniferous rocks in New Brunswick contains numerous beds of shales which are very suitable for making a large range of structural clay products. The shales in the Grand Lake coal basin have been very thoroughly examined and tested by the writer, but since then coal mining has been extended to new portions of the field revealing still other beds of shale in the operations. The Rothwell Coal Company have recently opened up a coal mine about 1 mile southwest of New Zion in Sunbury county, and a sample of the clay underlying the coal seam was sent to the laboratory for examination. This material differed somewhat from any of the other underclays in the Grand Lake district. It is grey fissile shale with films of carbonaceous matter, requires very little water in working and develops only a low plasticity. This shale (Lab. No. 621) can be dried fast after moulding without cracking and has a low drying shrinkage. The results given in burning are as follows:—

Cone.	Absorption.	Fire Shrinkage.	Colour.
	%	%	
06	11	0	Buff.
03	8	2	"
3	5	2	"
9	0	2	Brown.
15	Softened.		

This shale burns to a hard body with good colours at ordinary temperatures. Its fast drying qualities, low shrinkage and good colour recommend it for the face brick trade. The plasticity is rather low for the manufacture of hollow ware, but this might be improved by grinding in wet pans. It has semi-refractory qualities so that brick made from it might be used in positions where a high grade firebrick was not demanded.

This clay is not so refractory as the underclay at the old Rothwell mine near Minto.

No effort has been made so far to utilize the great resources in shales in the Grand Lake coal area for the manufacture of clay products.

CARAQUET—GLOUCESTER COUNTY.

West of the federal government wharf at Caraquet, a purple shale occurs in a bed about 15 feet thick. It outcrops for about 1,000 feet along the coast, is underlain by grey sandstone, and is overlain by a thin mantle of gravels. A similar bed of shale occurs farther west, outcropping on the shore opposite the church. At Clifton also it is exposed for about 1 mile along the coast, with a gentle dip eastward.

Samples from the exposures at Caraquet were collected by A. O. Hayes, and forwarded to the laboratory for testing.

Lab. No. 580.—Reddish-brown, crumbling, hard, massive clay shale, immediately west of the government wharf at Caraquet. This shale bed is about 15 feet thick, and is visible for about 1,000 feet. It is overlain by a thin deposit of gravels. This shale

when ground and mixed with water to the proper consistency has good plasticity, and excellent working qualities. It can be dried safely in artificial driers, up to a temperature of 150 degrees Fahrenheit, but may crack if forced in a higher atmosphere. The shrinkage on drying is about 6 per cent. When burned to cone 010, it has a good, hard, red body, with an absorption of only 9 per cent. If burned to the softening point of cone 03, the body is vitrified, but the fire shrinkage is high, being about 5 per cent. This shale fuses at cone 3.

Lab. No. 581.—Reddish-brown, crumbling, hard, clay shale near church at Caraquet. The outcrop of the deposit extends for about 300 feet along the shore of the bay, and lies westward of No. 580. This material is similar to sample No. 580, giving almost identical results in the tests in the raw and burned conditions.

These shales are suitable for the manufacture of wire-cut building brick, fireproofing or hollow ware and dry-pressed brick. They would probably work well for roofing tile, and stiff-mud floor tile. They could be made into rough face brick, and flashed to various shades of colour. They are of considerable economic importance, on account of their easily accessible location, and the superior quality of structural wares which they would produce. A cheap fuel supply could be brought in by water, and the finished goods shipped by the same means to western points. It is doubtful if paving brick could be made from these shales as their range of vitrification is too short.

In comparing these shales with those exposed on the shore between Stonehaven and Clifton the tests of which are given in the report of the Clay and Shale Deposits of New Brunswick, it will be seen that at the latter locality the shales are more refractory, and may be used for the manufacture of vitrified ware.

The deposits of Gloucester county are situated very conveniently both for railroad and water transportation, and occur in enormous quantities.

DEMOISELLE CREEK, ALBERT COUNTY.

A sample of clay from the walls of the Stedman and Murphy manganese mine near Demoiselle creek was collected by L. H. Cole of the Mines Branch, and tested in the laboratory. It is a light grey, plastic clay, containing numerous gritty particles, mostly quartz, burning to a hard, purple-red-coloured body at 1,850 deg. F. The material fuses at cone 5 (2246 deg. F.), so that it is not a fireclay. It might be used for the manufacture of face brick for building purposes, as the peculiar colour, due no doubt to the presence of manganese, together with the dense body, makes it very suitable for this purpose. The amount of clay available, however, seems to be so small that the above proposition is not worth considering from a commercial point of view.

CLAYS IN NORTHERN ONTARIO.

The stoneless clays found at or near the surface in northern Ontario, are nearly all composed of sediments deposited in glacial lakes which were formerly of large dimensions. Lake Abitibi may be taken as an example of the shrunken remnant of a once extensive lake of this character. The distribution of the clays are governed therefore, by the extent of territory covered by these lakes and the height to which the water encroached on the land surface, and to the subsequent drainage which extinguished or partly extinguished these lakes and made their sediments available as land surface. Considering the land area of northern Ontario as a whole, the areas underlain by stoneless clay sediments are very small and widely scattered.

The stoneless glacial clays in northern Ontario differ from the marine clays in the Ottawa and St. Lawrence valley in being almost always stratified in thin layers and frequently interlaminated with layers or films of silt instead of being massive and uniform in texture like the latter. They are similar in regard to their uses, being low grade, easily fusible clays, suitable only for the manufacture of common brick and field drain tile, and not for vitrified wares.

CLAYS ALONG THE TEMISKAMING AND NORTHERN ONTARIO RAILWAY LINE.

The rugged region between North Bay and North Cobalt, traversed by the Temiskaming and Northern Ontario railway, appears to be absolutely devoid of clay of any description, even boulder clay. The unconsolidated surface materials are sand, gravel, and boulder drift. At North Cobalt stratified glacial clays begin and continue in an almost unbroken stretch to Mindoka station, a distance of 50 miles. Between Mindoka and Bourkes stations the railway traverses the upland containing the watershed between the Hudson bay and Ottawa waters, in which clays are absent or confined to the bottom of the narrow valleys between steep rock ridges. Between Bourkes and Porquis, a distance of 40 miles, there are extensive patches of lands underlain by lake clays. Between Porquis and Cochrane there are no clays, the superficial deposits being either sand or gravel. Samples collected at the following points will serve to illustrate the character of these materials in general.

Haileybury.—A visit was made to the brick plant at this point in the summer of 1915 when the plant was in full operation. The clay bank, which is about 30 feet high, consists of alternating clay and silt layers, the clay layers are brown in colour and one-half inch to one inch thick, and the silt layers vary from half an inch, to mere films, the silt bands are ash-coloured, and are wider toward the top of the bank. Numerous concretions of hard limy clay occur in the upper 6 feet, but below this the clay is free from them. The lime content of this deposit is rather large, the silt layers being very limy. The bank is weathered to a brownish colour to a depth of 10 to 12 feet below the surface, but beneath the weathered zone the colour is dark grey. The sample taken for testing included an average of 20 feet from the surface, the results of the test being given in the table.

In working the clay for brickmaking about 25 per cent of rock tailings from the mines at Cobalt is added instead of sand. This mixture is passed through two pug mills, with a pair of rolls set between, and sent to a soft-mud machine for moulding. A stiff-mud machine was formerly used, but was found to be unsuitable, as too much loss occurred from cracked brick made by the process. It is found that the best results are obtained by moulding the clay as wet as possible in the soft-mud machine; but even then a considerable number of checked brick occur in every burning. The loss from checking could probably be still further reduced by the addition of a small

amount of common salt to the wet clay. The bricks after moulding are sent to a dryer heated with steam pipes, and some of the checking appears to occur here, especially in the lower part of the dryer cars nearest the steam pipes.

The burning is done in up-draft scove kilns, two of which are supplied with permanent side walls, the fuel used being wood. There is some loss in the fire arches from cracked and slagged brick, and others show fire checks above the arches. The best brick are hard, and ring when struck together, the colour is a good red, which is mostly imparted by the coating of moulding sand, as the body is somewhat pale or salmon colour. The Court House, Armouries, and Central Methodist Church, in Haileybury, are built of these brick, the latter being a specially good example of brick-work.

The use of Cobalt tailings for mixing with the clay should be noted. This is a crushed diabase and slate conglomerate and is the refuse from the mills of the mines around Cobalt. This material stands a little more heat than the clay without fusing, but it undergoes incipient vitrification along with the clay at the temperature of burning the brick, consequently it is sintered in the body and becomes part of it. An ordinary sand which is mostly composed of quartz grains is inert at this temperature and consequently if much is used becomes a source of weakness, and makes the burned brick punky. It would be useless to add it even in small quantities to a silty clay such as the above. Rock tailings of different grades of fineness can be obtained from the waste piles at the mines. The finest of all remains suspended in water for some time without settling. Experiments made with this material proved that it could be used as a dark brown glaze such as that produced by the Albany slip clay which is used so much for glazing stoneware goods. It matures between cone 7 and 9, and is a richer colour than the Albany slip.

Heaslip.—According to borings made for water at the railway station at Heaslip, the depth of clay in the clay plain at this point was 110 feet. In some places low ridges of rock or boulder clay protrude through this plain, so that the depth to which stoneless clay extends in the district is very variable. There appears, however, to be an abundance of stratified stoneless clay available at many points. The sample for testing was taken on the bank of a creek alongside the wagon road opposite 133 mile post on the railway, about 1½ mile south of Heaslip station. The clay here is brownish on top, grading to yellow to blue-grey below. It is well stratified, and contains films of silt between the clay layers. An average sample of 15 feet in thickness from the surface downward, a separate sample including only the bottom blue clay, and a small sample of the top brown clay, were taken at this point.

The clay at Heaslip does not contain such a large proportion of silt as that at Haileybury, it is consequently rather more plastic, and has the same drying shrinkage. Its drying qualities are not good, so that it must be dried slowly to avoid cracking. The working qualities of the average sample (No. 345) are fair, so that it can probably be used for making field drain tile except in the larger sizes. It burns to light red porous, but strong body at the lower temperatures, but turns lighter if burned higher. This clay would be suitable for making common brick, preferably by the soft-mud process. A moulding sand which burns to a good red colour should be selected, as the body colour is not good. About 25 per cent of sand should be added to this clay to improve the drying qualities and lower the shrinkages.

The bottom clay No. 346a is more silty than the average sample, consequently its working qualities are not so good, and it carries a higher percentage of lime. The higher content of lime causes it to burn to a buff colour and a more porous body. This material would make good buff building brick if used alone. It would not need the addition of sand as the shrinkages are low.

The top clay to a depth of about 2 feet below the surface is the most plastic and best portion of the deposit. It has good working qualities, burns to a strong red colour, and good dense hard body.

A layer of ash-coloured silt overlies the surface clay in the vicinity of Heaslip. It varies in thickness from a thin veneer to nearly 3 feet thick, and grades into a fine-grained sand or sandy loam in places. This material has a low plasticity, and can be moulded by hand. It burns to a pale red, very porous body, at low temperature, and in this form can be used for scouring purposes like bath brick. It gives better results as a polisher than most of the commercial bath brick on the market.

Matheson.—The village of Matheson and the immediate vicinity is underlain by stratified stoneless clay. Records of borings of two wells near the railway station showed 60 feet of clay, another showed 46 feet, and a fourth only 16 feet. Bed-rock crops out under the clay in the bank of Black river in the village. The clay rises in terraces to a height of 60 feet above the railway track a short distance south of the village. This clay is generally brownish in colour in the upper portion, but is bluish-grey below the weathered zone, and appears to be absolutely free from pebbles, concretions, or coarse grit. There is a layer of light grey silt scarcely a foot thick on the surface.

The sample of clay for testing was taken about a quarter of a mile east of the station, near the railway line, in a depression, where about 8 or 9 feet in depth were exposed. This clay, Lab. No. 344, when mixed with water to the proper consistency, has good working qualities, being very smooth and plastic. Its drying qualities are not good, so that it must be dried slowly after moulding to avoid cracking, and there is also too much shrinkage in drying.

The clay burns to a salmon-coloured porous body at the lower temperatures, but owing to its high lime content turns to buff when fully fired.

The addition of 25 per cent of sand improves the drying qualities and reduces the drying shrinkage by 2 per cent. With this amount of sand a very fair buff building brick can be produced, and it could also be used for making field drain tile. There is a certain amount of sand available in the high ridge near the village, but as the ridge carries a good deal of coarse and fine gravel mixed with the sand, it can only be obtained by screening.

The rock tailings from the mines at Porcupine added to this clay would make a better material for the purpose than sand, but the distance to the mines is too great to make this economically possible.

Porquis Junction.—About half a mile south of the station at Porquis Junction the railway cutting exposes a section consisting of 5 feet of brownish weathered and crumbling clay, underlain by 6 feet of banded brown and grey clay, with silt films, below which is 2 feet of dark grey stratified clay, the whole being from stones or concretions. This clay is similar to the deposit at Matheson in its qualities, having the defective drying qualities and high shrinkages which are characteristic of most of this area. A fairly good common brick, however, could be made from it by the soft-mud process, using about one part sand to three parts clay. The colours obtained are salmon to buff, depending on the heat of burning. Sand for mixing is not available in the vicinity of the deposit, but can be obtained about a mile or so to the north.

Timmins.—A sample of clay from this vicinity was shipped to the laboratory for examination, accompanied by a sample of sand. The clay was similar to that described from Porquis Junction, except that the sample appeared to be taken only from the upper weathered portion, and consequently, was rather more plastic and sticky when wet than if some of the bottom silty clay had been included.

Mixtures were made of three parts clay to one of sand, and two parts clay to one of sand. Both mixtures worked fairly well in the machine, the hollow tile coming perfect through a die without lubrication. The brick tore a little at the corners when passing out of the die.

In the drying tests the bricks made of three to one mixture cracked in the dryers at 120 degrees Fahr. Bricks kept at room temperature indoors for 2 days, and then exposed to wind and sun, were found to be checked shortly after exposing.

The samples of 4-inch drain tile and brick made by hand from the same mixture did not crack under the above conditions of drying.

Bricks made by hand from a mixture of two parts clay to one part sand, set to dry outdoors exposed to sun and wind, immediately after moulding cracked inside of one hour. When protected from the sun, but exposed to the wind, cracking ensued within two hours after exposure.

Samples of soft-mud hand made brick, of the three to one mixture, kept continually indoors at room temperature, dried in 7 days, and stiff-mud brick made on the machine required 9 days to dry.

The drying qualities of this clay are decidedly poor, and much care and patience would have to be exercised at this stage of the manufacture in order to avoid excessive losses. A clay of this type is known as a tender clay by brickmakers, and the deposits at South Porcupine, Porquis and Matheson have the same defect.

The sand which was sent with this clay was rather fine-grained, 85 per cent of it passing through the 100-mesh screen. It is suitable for a moulding sand for use in making soft-mud brick, but a coarser grade of sand would be more suitable for mixing. The coarse rock tailings from the gold mines in this district would give better results than sand, especially in the quality of the burned ware.

NATIONAL TRANSCONTINENTAL RAILWAY.

Cochrane to Hearst.—The region traversed by this railway is a slightly undulating boulder clay plain, still covered with much forest and swamp growth. Occasional shallow cuttings along the line show the generally stony character of the clay which unfits it for the most part for purposes of brick and tile making. The principal areas of stoneless clay appear to occur in the depressions through which the larger streams of the region flow. At many other points the surface clay contains so few pebbles or stones that they may be used for brickmaking, although the deposits are not deep as a rule and pebbles are invariably encountered at depth. Such clays may not be more than 1 to 3 feet deep. In this respect the deposits are of a similar character to those found in southwestern Ontario, particularly in Essex county, where the clay worked for brick and tile is a surface layer of only 18 inches, lying upon stony clay. Most of the clays found in these stoneless patches contain a high percentage of lime and are buff burning, showing that the leaching processes of weathering which in time remove the excess of lime did not penetrate very deeply in this region. Some of these clays found in Brower and Lamarche townships will make as good buff stock brick and drain tile as any produced in the older parts of the Province.

ALGOMA, THUNDER BAY, AND RAINY RIVER DISTRICTS.

Several large deposits of glacial clay suitable for brick and tile manufacture are found at Sault Ste. Marie, Fort William, and other localities in these districts. A full report of these materials is in preparation.

SUMMARY TABLE of Physical Tests of Surface Clays in Northern Ontario.

Locality.	Lab. No.	Water required for Mixing.	Drying Shrinkage.	Cone 010.		Cone 06.		Cone 03.		Remarks.
				% F.S.	Absorp.	% F.S.	Absorp.	% F.S.	Absorp.	
North Bay, Nipissing	242	25	6	0	18	0	15	3	5	Very silty clay.
Sturgeon River, "	244	25	6	0	21	0	20	5	9	Good working qualities.
Haileybury, Timiskaming	348	27	8	0	20	1	20	1·3	16	Average sample of deposit.
Haileybury, "	348	25	6	0	19	0	18	1	17	With 20% mine tailings.
Heaslip, "	345	29	8	0	19	0	19	1	16	Average at deposit.
Heaslip, "	346	20	6	0	13	....	....	2	9	Top clay, burns red.
Heaslip, "	346a	....	6	0	21	0	21	1	20	Bottom clay, burns buff.
Matheson, "	344	27	9	0	18	1	18	3	18	Buff burning.
Porquis, "	343	30	8	0	21	1	21	1·3	18	Fire checked.
Hearst, Algoma	342	....	7	0	29	1	20	1·3	17	Contain lime pebbles.
Steelton, "	334	26	7	0	16	0·5	17	1·7	13	Contain lime pebbles.
Steelton, "	335	22	7	0	12	1	10	2	8	Elliots brickyard.
Rydal Bank, "	587	....	9	0	17	0	17	8	0	Top clay.
Rydal Bank, "	587a	....	5	0	15	0	15	6	3	Bottom clay.
Sudbury, Sudbury	245	19	4	0	15	0	14	0	10	Very silty clay.
Fort William, Thunder Bay	336	27	7	0	16	0	15	1	14	Alseps brickyard.
Port Arthur, "	339	....	3	0	16	0	15	1	14	McIntyre river.
Rosslyn, "	340	....	7	0	20	0·5	19	1	16	Superior Brick Co.
Finmark, "	341	30	8	0	14	0	13	1	13	With 25% sand.
Mine Centre, Rainy River	611	34	8	1	22	1	21	11	0	Bottom clay.
Mine Centre, "	612	31	10	....	....	6	2	....	....	Top clay, fire checked.
Fort Francis, "	276	23	7	0	18	0	15	0	14	Not overfired at cone 1.

Equivalent approximate temperatures— Cone 010 1,742 Degrees F. 950 Degrees C.
" 06 1,886 " 1,030 "
" 03 1,944 " 1,090 "

FIRECLAYS ON MISSINAIBI AND MATTAGAMI RIVERS.

Missinaibi river.—The occurrence of deposits of fire and pottery clays on the Missinaibi river in northern Ontario, have long been known, and were described by J. M. Bell in the annual report of the Ontario Bureau of Mines for 1904. These deposits outcrop on the bank about 8 miles above the mouth of the Wabiskagami river, and are also exposed on the banks of the latter river. According to borings made by the holder of the property in 1913 the greatest thickness of clay was said to be 74 feet, measured from the river level to the top of highest portion of the bank where clay was found. The deposit consists of beds of white, pink, buff, and grey plastic clays, with sandy clay, or white sand layers.

A sample of this clay was secured from Mr. W. Tees Curran of Montreal—one of the owners of the deposit. This sample, Lab. No. 620, was of the light grey or white beds, with a few pieces showing pink colour. In a washing test 70 per cent passes through a 200-mesh screen, the material coarser than this being little worn and angular quartz grains. The dry clay requires 27 per cent of water to bring it to the best working consistency for moulding. The plasticity and working qualities are good, and the shrinkage on drying is about 5 per cent.

This clay burns white up to cone 3, but when burned to cone 9 (1310 deg. C.) the colour darkens, but the body is still porous. The softening point is about 28 (1690 deg. C.) which classes it as a fireclay. The chemical analyses of this clay shows it to contain iron and titanium in appreciable amounts, which are responsible for the darker colour of the clay at high temperatures, which unfits it for use in white pottery ware, but there are probably some beds of white clay in the deposit free from this defect. The buff and pink clays contain still more iron and are not refractory enough to be classed as fireclay.

A mixture of the clays could probably be used for making pottery of the stoneware type.

Mattagami.—Fireclay was first discovered on the Mattagami river during the summer of 1917 by C. M. McCarthy of Elk Lake, who reports the occurrence in the river banks, a short distance below the foot of the long portage; and sent a sample to the Mines Branch laboratory for examination. This clay, Lab. No. 618, is nearly white in colour when dry. When washed and passed through a 200-mesh screen, only 10 per cent remains behind, composed of small quartz grains. It requires 23 per cent of water to bring it to the best wet condition for moulding; and is then very plastic and smooth, with excellent working qualities. It dries readily with a drying shrinkage of 6 per cent. The clay burns white up to cone 3, but some dark specks show in the body when burned to cone 9. At the latter temperature it is still porous, the absorption being 9 per cent. This clay is still intact when raised to the softening temperature of cone 31 (1,750 deg. C.) in a carbon resistance electric kiln, and softens at cone 33, so that it is a number one fireclay.

When submitted to a washing and settling process, about 75 per cent of fine pottery clay can be obtained from the crude material. The washed clay was dried and made up into a standard porcelain body of the following proportions:—

Washed Mattagami clay..	50 per cent.
Ground feldspar..	20 "
Ground quartz..	30 "

This mixture was made into a slip, and cast in the form of small cups. These were biscuited in a commercial china kiln at cone 10, then glazed and re-fired at cone 4. The pieces turned out had a beautiful ivory tone, but as the china trade demands whiteness, the clay would require the addition of a little cobalt stain in order to meet the requirements of that industry.

This clay would probably be suitable for the manufacture of crucibles used in the metal melting processes.

The following analyses shows the chemical composition of these clays:—

	I	II
Silica	58·90	53·10
Alumina	26·63	31·92
Ferric oxide	1·40	1·52
Titanic oxide	1·25	Not determined.
Lime	0·56	0·51
Magnesia	0·16	Trace.
Manganese	0·01	Not determined
Potash	0·31	0·28
Soda	0·42	0·54
Water	10·30	12·35
	99·94	100·22

I. Missinaibi clay, No. 620. Analysis by M. F. Connor, Mines Branch.
II. Mattagami clay, No. 618. Analysis by W. K. McNeill, Ontario Bureau of Mines.

High grade clays of this description have not been found so far in any other place in Ontario, although they have been diligently sought for. It is unfortunate that the above deposits are located in such a remote region, without transportation facilities, and 50 miles from the nearest point on the National Transcontinental railway. It is possible that in further prospecting other valuable deposits of this kind may be found nearer the railway line.

MANITOBA.

GREATER WINNIPEG WATER DISTRICT RAILWAY LINE.

Surface clays suitable for the manufacture of common brick and drain tile in the Province of Manitoba have been examined and reported on in previous work by the writer. Within the last few years the construction of the Greater Winnipeg Water District railway from Winnipeg eastward to Shoal lake has revealed the presence of the brick clay along almost its entire length. The greatest thickness of the clay occurs toward the eastern extremity of the line, where it reaches a depth of 16 to 20 feet below the surface. These clays are yellowish in colour, carry a rather high lime content, but make a good hard buff brick when well burned and are best adapted for the soft-mud process of manufacture.

HUDSON BAY RAILWAY LINE.

A belt of stoneless clays extends for about 100 miles along the Hudson Bay Railway line, from mile 116 to mile 214, which will be found suitable for the manufacture of common building brick if required.

A sample collected at Piquitona by W. A. Johnston of the Geological Survey, was examined in the laboratory. It is a drab calcareous clay, fairly smooth when wet, having good plasticity and working qualities. Its drying shrinkage is rather high, and it is better to dry it slowly to avoid cracking.

The clay burns to a hard, but porous, salmon-coloured brick, but if fired at too high a temperature it shrinks greatly and the colour becomes bad. The clay should be worked by the soft-mud process of brickmaking, the addition of a little sand would improve the drying qualities and reduce the shrinkage. The commercial limit of burning is about 1800 Fahr., if a pyrometer is used, or cone 96 if pyrometric cones are used. There are occasional grains of limestone in the clay, but if they do not run larger in the deposit than those in the sample they will not do much damage to the burned brick.

SHALE AND SAND DEPOSITS AT SWAN RIVER.

In the report by Mr. J. B. Tyrrell on the geology of northwestern Manitoba, published in 1892, a series of sand and clay deposits of unusual character occurring on Swan river was described. At that time and for many years later this portion of Manitoba was almost entirely unsettled, and the deposits were not considered of economic importance.

It seemed probable from the description of these deposits that some of the clays might prove to be refractory and that the sands might be adapted for the manufacture of glass, and hence be of considerable value at the present time. Mr. W. A. Johnston examined the locality during the past season at the request of the writer, and secured samples of the clay and sand for testing.

The former is a grey clay shale, very gritty, as it contains a quantity of fine sand and numerous scales of mica. It requires only 17 per cent of water to bring it to the best working consistency, it is then fairly plastic and will work well in almost any kind of clay-working machinery. Its drying qualities are good and owing to its sandy texture the shrinkage on drying is small, being less than 5 per cent.

The following results were obtained on burning:—

Cone.	Fire Shrinkage.	Absorption.	Colour.
	%	%	
010	0·0	12	Pink.
06	1·0	9	Buff.
03	1·7	8	"
3	1·7	7	"
9	3·0	2	Dark buff.
20	Softens and deforms.		

The body is steel hard at cone 06, and the colour a fine bright buff, the colour darkens as the temperature is increased and at cone 9 numerous fused iron specks appear at the surface, and the body is practically vitrified.

This material is suitable for the manufacture of various shades of buff face brick, made either by the dry-press or stiff-mud process, and could also be used for hollow building blocks or fireproofing, or even for architectural terra-cotta.

It could probably be used for sewer pipe and electric conduits, and brick for boiler settings and stove linings. It is not quite refractory enough to be classed as a fireclay, but its semi-refractory qualities make it desirable for vitrified ware. It is the most useful clay so far discovered in the Province of Manitoba.

The clay is overlain by a bed of fine-grained quartz sand containing numerous grains and pellets of dark coloured pasty clay.

When the sand is dry practically all of it passes through a 40-mesh screen, but the clay particles do not, so that a fairly clean separation of the clay and sand can be made.

The following mechanical analysis shows the grain size:—

Retained on 60-mesh screen	13·70	per cent.
" 80 " "	40·20	"
" 100 " "	25·54	"
Through 100 " "	19·96	"

A partial chemical analysis shows the presence of 96·42 per cent of silica, and 0·17 per cent of iron; the balance being probably alumina.

The low iron content of the sand suggests its use for the manufacture of glass, if its texture is not too fine for this purpose.

The deposits of refractory clay and glass sand are exposed in the banks of Swan river in sections nine and ten in township thirty-seven, range twenty-six, 9 to 10 miles down stream from the town of Swan River. The clay where best exposed in a steep bank on the north side of the river near the line between sections nine and ten, outcrops near the water's edge and has a maximum thickness of 12 feet, but has, at this locality, an overburden of about 35 feet of sand and clay. The clay also outcrops above this point along the lowest terrace of the river where it has only a slight overburden. The glass sands overlie the clay. They are 10 to 15 feet in thickness and outcrop at several points along the river at this locality.

BRITISH COLUMBIA.

Diatomaceous earth.—Numerous samples of material which was said to be kaolin have been received from various persons in British Columbia during recent years. The majority of these samples proved to be diatomaceous earth, but a few of them were volcanic ash. One sample appeared to be a mixture of diatoms and ash. The localities given for the occurrence of these deposits are Deadman lake, about 35 miles north of Savona station on the Canadian Pacific railway, also from a point 18 miles north of Ashcroft, and others are indefinitely stated to have come from the Kamloops district.

A chemical analysis of two of these samples is given on page 53 in the Summary Report of the Geological Survey for 1916.

The diatomaceous earth is a soft white chalky material, much lighter in weight than clay, and has little or no plasticity when wet. Its light weight and lack of plasticity readily distinguishes it from kaolin in the field.

Volcanic ash is often very white, and is denser than diatomaceous earth. It is sometimes mistaken for kaolin, but it is entirely without plasticity, and is altogether different in composition.

Mr. C. Camsell of the Geological Survey collected some samples of diatomaceous earth from Quesnel in 1917. He states that there is a vast quantity in the beds at that locality.

A good insulating brick can be made from it by adding about 25 per cent of good plastic clay and some sawdust. The mixture is moulded and burned as in ordinary brickmaking. There is a good plastic clay at Quesnel which would be suitable for such a mixture.

All the deposits of diatomaceous earth so far noted in British Columbia appear to be situated too far from railway lines to be readily available. Up to the present no occurrence of kaolin has been recorded in British Columbia, but it probably will be found there.

II

POTTERY CLAYS.

A great variety of clay wares are included in the general term pottery, but popularly it is understood as some sort of vessel or object either for purposes of utility or ornament. In this restricted sense pottery includes table ware, cooking ware, jugs and crocks, art pottery, and flower pots.

TABLEWARE.

This includes porcelain or china, semi-porcelain, hotel china, ironstone china, white earthenware, etc. The clays which enter into the composition of these wares are kaolin or china-clay and ball clay, the other ingredients being flint and feldspar.

Kaolin.—There is only one workable deposit of white kaolin so far known in Canada. It occurs at St. Remi d'Amherst in Argenteuil county, Que., and is owned and operated by the Canadian China Clay Company of Montreal. This clay is suitable for the manufacture of any of the above grades of table ware. The manufacturers of electrical and sanitary porcelain in Canada import their kaolin from Cornwall, England.

Ball clay.—This is a highly plastic white burning clay, added to the other ingredients of table ware bodies to make them workable, but is not indispensible for the manufacture of porcelain.

Deposits of ball clay are at present unknown in Canada, but some of the highly plastic white clays in Saskatchewan approach it closely in character.

There are no potteries in Canada for the manufacture of table ware, the supply mostly all coming from the pottery centres in England, and Japan, but a small portion comes from the United States. Formerly most of the table ware used in America was imported from Germany and Austria.

STONEWARE GOODS.

Pottery made from stoneware clays includes teapots, kitchen bowls, jugs, crocks, and various other articles for domestic or dairy uses. Stoneware clays are fine-grained, plastic, refractory or semi-refractory materials, burning to dense or vitrified cream, buff, or grey coloured bodies at a temperature of about 2,200 deg. Fahr. The stoneware clays are generally used by sculptors for modelling purposes, and in schools where modelling in clay forms part of the instruction. Owing to their smoothness, plasticity, and tensile strength, in the raw state, these clays are admirably suited to making wares by hand on the potters wheel. Some of the finest work in glazed ornamental pottery is done in stoneware clays.

Clays of this type occur at three points in Nova Scotia, at Shubenacadie, Middle Musquodoboit, and Inverness. In northern Ontario white pottery clays are known to occur on the Missinaibi and Mattagami rivers, and are described elsewhere in this report. Stoneware clays occur in the greatest abundance in the southern part of the Province of Saskatchewan, situated conveniently to railways. These clays are described in a special report on that area, issued by the Mines Branch.

The stoneware clays are not known to occur in southern Alberta, but there are a number of beds of this type of clay on the Athabaska river below Fort McMurray in the northern portion of the Province.[1]

[1] Ells, S. C. Notes on Clay Deposits near McMurray, Alberta, Bulletin No. 10, Mines Branch.

No stoneware clays have yet been found in the Provinces of New Brunswick, Quebec, Manitoba, or British Columbia, but they probably occur at the latter.

Pottery made from stoneware clays are manufactured at St. John, New Brunswick, by Messrs. Foley Bros., the clays used being brought to this point from New Jersey and Middle Musquodoboit, Nova Scotia; and at Iberville, Quebec, by E. L. Farrar, from New Jersey clay. The pottery of R. Campbell Sons in Hamilton, Ontario, is the most extensive of the kind in Canada. Teapots and glazed kitchen ware is the principal output, the clays being imported from Pennsylvania and New Jersey. The Medalta Pottery in Medicine Hat, Alberta, manufactures domestic glazed ware of stoneware clay brought from East End, Saskatchewan.

ART POTTERY.

An extensive range of articles for use and ornament is included under this title, from porcelain ware to ware made from brick clay. These wares are generally coated with a glaze or enamel, but not necessarily so unless the ware is required to hold water. If the body is vitrified, however, it is impervious to water without the coating of glaze.

Any clay or mixture of clays which possesses the requisite qualities for modelling, casting, pressing, or throwing on the potters wheel, may be used in this class of pottery. A great part of it appears to be made from the same ingredients as those used in the manufacture of table ware, viz., a mixture of china-clay, ball clay, ground quartz, and feldspar. Stoneware clays are also used extensively, or a mixture of ground quartz and stoneware clay.

For the cheaper grades of pottery the body may be of any colour and porous when burned, such wares are generally coated with opaque glazes, so that the colour of the body is concealed, and are known as majolica or faience.

It is better to wash many of the stoneware clays mentioned above, especially those in Saskatchewan in order to separate certain coarse-grained impurities which they contain.

The brick and tile clay at some localities, either red or buff burning, may be used for pottery, and others may be washed and rendered suitable. One of the best of the common clays which we have found, occurs in Prince Edward Island, and is worked for brick and tile at Richmond.

This clay may be used as it comes from the bank in places, but at others it contains much fine grit. When put through a washing process to remove the coarse grit, this clay is exceedingly smooth and plastic, and equal to the finest modelling clay. It burns to a fine clean, red colour, and dense body, at temperatures from cone 010 to 05. Its drying and firing qualities are good, and really fine work with coloured glazes or enamels may be done on it. A red clay of somewhat similar quality may be obtained in the Annapolis valley, Nova Scotia, at Avonport, Middleton, Bridgetown, and Annapolis.

Good common clays for pottery occur at Hamilton, Ontario, both red and buff burning. The latter is a glacial clay, occurring at Bartonville, or on the Canadian Pacific railway line between Hamilton and Waterdown. It is stony, and requires washing, when it will yield a very smooth, strong, and plastic, buff clay. The weathered top of the Medina shale which occurs at intervals between Waterdown station on the Grand Trunk railway and Grimsby, is a smooth, plastic, red burning clay, suitable for work on the potters wheel. This material is used by the manufacturers of sewer pipe in Ontario at Hamilton, Mimico and Swansea, the clay being brought to these works by rail.

Art pottery is not made in Canada at present, so that it is impossible for visitors to purchase any native ware in this country. The goods of this class sold in shops

is imported from England and the United States, but Japan is rapidly becoming the chief manufacturer and exporter of these goods.

FLOWER POTS.

The unconsolidated stoneless surface clays, such as are used at many points for the manufacture of brick and tile, are suitable for the manufacture of flower pots. The clay for this purpose must be plastic, and easily worked, but the shrinkage must not be too great, nor should it burn to a body which is too dense at low temperatures. It is desirable to have a good red colour, and a porous, but strong body in the finished ware.

The stoneless clays used for brickmaking in the Maritime Provinces would be well suited to the manufacture of flower pots; the clay from Prince Edward Island, described above, being specially recommended. The marine clays in the St. Lawrence and Ottawa valleys, generally, have too high a shrinkage, and are hard to dry, although the addition of some fine red burning sand might make them workable. Several examples of red burning surface clays in southwestern Ontario are suitable for flower pots. The largest factory for their manufacture in Canada, the Foster Pottery Company, is located at Hamilton.

Flower pots were formerly made by hand on the potters wheel, and a small quantity are still made by this method in Canada. The best hand-made pots are somewhat irregular in shape and size, so that they do not nest perfectly, and many are broken in transit, unless the greatest care is taken in packing them. Pots are now mostly made by machinery, and are much more accurate in shape and size. A flower pot press, with two men or boys, will turn out 5,000 pots per day.

III

MAGNESITE.

Magnesite is now largely employed for high-grade refractories owing to the development of the basic process in steel production. In this process, the refining of the metal is effected in presence of a highly basic slag, or one rich in lime; the result being to eliminate not only carbon, silica, and manganese, from the cast-iron, but also phosphorus, which cannot be removed in the presence of an acid slag, or one having an excess of silica.

Bricks made of silica or fireclay are unsuitable for furnace linings where basic slags are used, as these materials soften too easily in contact with lime. Magnesite bricks, on the contrary, being themselves basic in composition, offer complete resistance. In all basic furnaces, the sole and lower part of the vertical walls is built of magnesite, the arch being always constructed of silica brick.

The direct contact of magnesium and silica brick will provoke mutual fusion, so that ferro-chromium brick, which act neither on silica nor magnesia, are used to separate them.

A good deal of the Quebec magnesite from Grenville township is used for furnace bottoms, without being made up into brick shape, the method of using it, being as follows:—

The magnesite is first calcined in the manner in which limestone is burned to produce lime. This calcined material is broken into small pieces of one-half inch or less in size, and is mixed with crushed basic open-hearth slag in varying proportions. The furnace to be lined is then brought up to a temperature of 2,700 to 2,800 degrees Fahr., and the mixture of magnesite and slag is thrown in on the bottom of the furnace, in small doses, care being taken to distribute the material evenly, the bottom being built up in successive layers, as the mixture becomes sintered, until the required thickness is completed.

When magnesite is burned to a high temperature so that it shows no shrinkage in further heating and does not crumble on exposure to air it is said to be dead burned.

Dead burned magnesite is produced by the Scottish-Canadian Magnesite Company, in the plant of the Canada Cement Company, at Hull, Que. In this process, the magnesite, as it comes from mines in Grenville township, is mixed with 6 per cent of iron ore from the Forsyth iron mine at Ironsides. The mixture is passed through a jaw crusher and ball mill, until reduced to pass a 100-mesh screen.

The ground mixture of raw magnesite and iron ore is fed to one of the rotary kilns ordinarily used for burning cement, and fired at a temperature of probably 2,800 degrees Fahr., the fuel used being powdered coal, blown into the kiln under air pressure. It requires about one hour for the material to travel through the kiln, which is 60 feet long. The burned product is a dense, hard, granular material, of dark brown colour, and about the size of fine gravel. This product is known as grain magnesite, and is supplied to steel manufacturers for lining the bottom and sides of forging, heating, and welding furnaces.

The iron ore is added for the purpose of sintering the magnesite into a dense hard material, as it would be extremely difficult to dead burn the magnesite unless the iron was present to act as a flux or binder. The finely divided state in which the raw magnesite enters the kiln also facilitates the burning, as it certainly would not become dead burned at 2,800 degrees if put through in lump form.

The following chemical analyses show the changes that occur in the raw magnesite when converted to the dead burned condition:—

	A	B
Silica	2·60	6·3
Alumina	1·40	1·9
Iron	0·34	6·4
Lime	9·78	16·5
Magnesite	35·80	69·0
Carbon dioxide	47·10	—
Water	0·83	—

A. Average sample of raw magnesite from Grenville township, Argenteuil county, Que. Analyst, R. T. Elworthy, Mines Branch.

B. Dead burned magnesite from Hull, Que. (6 per cent of iron ore added to raw material before burning). Analyst, S. G. McAnally.

A sample of the dead burned magnesite of composition B was submitted to heat treatment in a carbon resistance electric furnace heated up to the softening point of cone 34 (1,810 deg. C.) The material was not affected at this temperature, and it withstood the effect of the heat as well as a brick made from Austrian magnesite, upon which it was supported.

The practice of dead burning magnesite began in the Hull cement plant in October, 1917, using one rotary kiln, and producing about 35 tons of grain magnesite per day. The demand for this product has increased to such an extent that three kilns were in operation by May, 1918, producing about 100 tons per day.

MAGNESITE BRICK.

Several patents have been taken out with the object of making magnesite brick from raw magnesite in one operation of burning, by adding chrome iron ore as the sintering material in amounts up to 30 per cent. Some test pieces of the above mixture were prepared by the writer, and burned at cone 25. The results of this test showed, that the shrinkage in the burned bricklets was so great, that the operation could not be regarded as being within the range of practical brickmaking. Moreover, the bricklets air slaked and crumbled within two months after being burned. The crumbled material made up into bricklets and burned the second time, also disintegrated some time after reburning.

Several other sintering materials, such as serpentine, iron ore, and kaolin, in amounts of 5 to 10 per cent, were tried, but without success. A mixture containing 90 per cent of raw magnesite ground to pass a 10-mesh screen, 5 per cent of iron ore, and 5 per cent of kaolin, gave the best results, as it did not air slake and crumble after burning, but the shrinkage was abnormal.

It appears certain that two burning operations are imperative in the manufacture of magnesite brick. The first burning may only be carried to the calcining temperature so as to drive off most of the carbon dioxide. This operation also takes a large part of the shrinkage out of the material.

If dead burned magnesite is used for brickmaking it is usual to add 15 per cent of light calcined magnesite with 85 per cent dead burned. This mixture is thoroughly milled in wet pans, moulded by hand into brick shapes, and when partly dry, are re-pressed by machinery.

In order to develop a bond and produce a strong hard brick, the burning must be carried to a very high temperature, usually from 1,500 to 1,700 degrees centigrade; or from cone 20 to cone 30, according to the composition of the material.

If raw magnesite is used for brickmaking, the operation consists in mixing about 10 per cent of iron ore with crushed raw magnesite, and milling the mixture in wet pans. The mixture is made into brick shapes by hand, and burned in kilns at the calcining temperature, or about 1,000 deg. C. The calcined bricks are broken down and milled a second time in wet pans, and pressed into brick shapes by machinery. These are set in kilns when dry, and burned to the necessary high temperature.

Previous to the year 1915, the United States relied almost entirely upon the supply of Styrian magnesite, which was imported largely in the calcined state. Since then, the hitherto unworked magnesite deposits in California and Washington have been drawn upon for use in the steel industry. Brickmakers in Britain imported both Styrian and Greek magnesite before the war, but since then magnesite brick are made of magnesite from the Indian and Greek deposits.

The following chemical analysis gives the composition of the various bricks:—

	1.	2.	3.	4.
Silica	1·85	7·38	7·0	6·82
Alumina	2·47	1·36	7·0 (Alumina and Iron)	1·28
Iron	5·95	7·72		1·88
Lime	3·45	7·85	1·0	3·78
Magnesia	85·40	73·80	85·0	83·50
Alkalis	0·31	....	....	0·34
Loss on ignition	0·66	1·89	....	2·48

1. American made brick in 1914. Analyst, R. T. Elworthy.
2. " " 1917. " S. G. McAnally.
3. " " 1918.
4. British made brick in 1917. Analyst, R. T. Elworthy.

Greek magnesite has usually more silica and lime, but much less ferric oxide than Styrian magnesite. Canadian magnesite[1] is irregular in composition, but usually carries more lime and less iron than the European materials. The Washington magnesite is similar in composition to the Canadian occurrences.

Some experiments in brickmaking were made in the laboratories of the Mines Branch on the grain magnesite produced at Hull. This material is very hard, so that when it is crushed and screened to the size of grain ordinarily used for brickmaking, it is found to be very gritty, and when wetted has no coherence, so that it would be impossible to press such a material alone, either by hand or by machinery. It is necessary, therefore, to add a bonding material which will enable the brick to be handled without damage as it comes from the presses.

Lightly calcined magnesite which has a pasty consistency when wet is usually employed in amounts varying from 6 to 15 per cent. When this mixture is thoroughly milled in wet pans it has sufficient coherence for moulding, and can be made into brick shapes.

If the dead burned magnesite is ground very fine, so that there is considerable dust in the ground product, it is possible to mould it in a damp state without a bond in presses similar to those used for making dry-pressed building bricks.

The best results were obtained by grinding the material so that it all passed a 16-mesh screen with 45 per cent passing through a 100-mesh. When ground to this texture the magnesite simply requires to be slightly moistened to prepare it for pressing. After being pressed and dried the bricklets harden so that they can be readily handled for setting in the kiln. The shrinkage after burning to cone 25 (1,630 degrees C.) was 2 per cent.

If the magnesite is ground very fine, so that it all passes through a 100-mesh screen, fire checks are liable to develop in the burned brick, and the shrinkage will be higher.

SPALLING OF MAGNESITE BRICK.

One of the chief defects of magnesite brick is failure from spalling and disintegrating in use under repeated heating and cooling. The disintegration is very much hastened in the presence of the action of steam, even on thoroughly burned brick made with magnesite very low in lime or other impurities. In making some experiments on magnesite brick for the Royal Mint the writer found that all the trial pieces made up with the ground Canadian dead burned magnesite bonded with light calcined mag-

[1] Magnesite Deposits of Grenville district, Argenteuil county, Que., M. E. Wilson. Memoir 98, Geological Survey.

nesite, were subject to spalling when set in the furnaces at the Mint. Brick made from Styrian magnesite behaved no better in this respect. When the Canadian dead burned magnesite was bonded with 5 or 6 per cent of china-clay, however, neither spalling or disintegration occurred during prolonged trial in place in the furnace.

The brick made with 12 per cent china-clay as bonding material, and burned to cone 25, were very dense and strong, with a flinty fracture, but they have a tendency to deform if burned to a higher temperature than this. When the magnesite is ground to pass a 12-mesh screen, bonded with 6 per cent of china-clay, and burned at cone 25, a much stronger brick is obtained than when calcined magnesite is used. Furthermore, it has the advantage of not being so liable to spalling and disintegration. The objection, however, to the use of clay as the bonding material is, that it increases the silica content of the brick, so that it may not be able to withstand the corrosive action of basic slags, or the great heat in the roofs of electric furnaces.

The following chemical analysis shows the approximate composition of the grain magnesite from Hull when bonded with 6 per cent of kaolin.

Silica	10·52
Alumina	4·18
Iron	6·00
Lime	14·5
Magnesia	64·18

IV

SILICA.

Silica, in the form of flint nodules found in the chalk formations in England and France, is used extensively in the various pottery industries. The flint nodules are calcined, and then ground either in wet pan mills or in cylinders, until it is fine enough to pass through a 150 mesh screen. Flint nodules are imported into the United States and ground for the potteries at Trenton, New Jersey, and at East Liverpool, Ohio.

Flint nodules do not occur either in the United States or Canada, but the pure varieties of sandstone are used, when finely ground for the use of potters. The ground product made from either the flint nodules or from sandstone are known to potters as flint, and from 20 to 50 per cent of flint is used in all white pottery bodies.

There are no grinderies for the production of flint in Canada at present, although there is a good demand for finely ground quartz, not only by the potteries, but by various other industries as well—the paint manufacturers, for example.

During the summer of 1917, Mr. L. H. Cole of the Mines Branch, examined various localities where sandstones occur, and collected samples. About 36 samples of the material were submitted to the writer for testing.

The sandstones were crushed in a jaw crusher, and then ground in a porcelain jar mill, until they were fine enough to pass a 150 mesh screen. The ground product was mixed with standard china-clay, ball clay, and feldspar, and made up into test pieces, the amount of ground quartz used in each case being 40 per cent of the body. The trial pieces were burned to cone 5 in an oil fired muffle kiln, and afterwards compared with a standard for colour. Chemical analyses of the sandstones were also made.

The majority of the test pieces were either pink or grey in colour, due to an excess of iron either in a finely divided state or in minute grains which showed as black specks on the surface of the burned trial pieces.

The following six samples compared favourably with the standard:—

Sample No.	
10.	4 miles from Hemingford, Huntingdon county, Quebec.
19.	Lot 8, con. VII, centre of lot, North Crosby, Leeds county, Ontario.
25.	South half of lot 26, con. X, Elmsley North, Lanark county, Ontario.
35.	North half of lot 16, con. VII, Pittsburg, Frontenac county.
51.	St. Canute, Quebec, Stinson-Reeb property.
53.	Nepean sandstone quarries, Nepean, Carleton county, Ontario.

The following five samples were not quite as good as the standard but are white enough to be classed as fairly good:—

Sample No.	
5.	Between Hemingford and Vicars, Huntingdon county, Quebec.
38.	Run-of-quarry, Oneida Lime Co., Nelles Corners, Haldimand county, Ontario.
41.	Tailings from washing plant, Oneida Lime Co.
42.	North side of quarry, Oneida Lime Co.
48.	Lot 20, con. II, Lansdowne, Leeds county, Ontario.

The greater part of the samples were taken from outcrops of the Potsdam sandstone, which are the basal beds of the Palæozoic rocks in eastern Ontario and the adjoining portions of Quebec. Only the lighter coloured beds in the formation were sampled, as the yellow, reddish, and dark grey beds do not burn to a white colour, on account of their high iron content. These sandstones are somewhat friable, and break down easily in crushers, so that they are easily prepared for fine grinding. They are

crushed and washed at Melocheville in Beauharnois county, Quebec, and shipped to Montreal for the manufacture of glass.

The Oneida Lime Company work the Oriskany sandstone, which outcrops at Nelles Corners, for the manufacture of glass. This formation is restricted to a small area in southwestern Ontario, and does not occur so widespread as the Potsdam sandstone in eastern Ontario.

Extensive deposits of sandstones low in impurities occur in Kamouraska county along the Intercolonial railway line near St. Pascal, and on Pilgrim Island in the St. Lawrence river.

There is a large quantity of quartzite rock in the kaolin deposits at St. Remi d'Amherst in Argenteuil county, Quebec, which is probably suitable for ceramic purposes.

SILICA BRICK.

Various samples of quartzite and sandstone were tested in the laboratory during the past season, in order to determine their suitability for the manufacture of silica brick. The results confirmed those previously made, that quartzites suitable for this purpose are not of frequent occurrence. All igneous quartz and many quartzites that have been tested showed a tendency to undue swelling under heat treatment, causing the body of the test pieces to become punky and friable, and having no structural value. A good quartzite under the same condition shows only a slight swelling, while the resulting body is compact and strong. The materials were all crushed to pass a 10 mesh screen, and 2 per cent of quicklime was added for bonding purposes. The temperature of burning was about 1,500° C.

In the results of experiments made for the improvement of the manufacture of silica brick in France, it is stated that if the granulometric composition of the crushed material is right, that any form of quartz may be used. It is claimed that if 30 per cent of the material be in the form of impalpable powder, that igneous or vein quartz, as well as any variety of quartzite, will be suitable.

Experiments made in the Mines Branch laboratory did not confirm this statement, as far as igneous quartz was concerned; but the addition of the impalpable powder to good quartzite was found to be an improvement to the strength of the burned bricks.

The best results seem to be obtained by grinding the quartzite in ball mills until fine enough to pass a 200 mesh screen, and adding 25 or 30 per cent of this powder to the coarsely crushed material. The coarse materials may have grains as large as those passing a 6 mesh screen.

Sault Ste. Marie, Ont.—The manufacture of silica brick is carried on by the Lake Superior Corporation. The output of the plant is small as it is only designed to supply refractories to the various subsidiary companies included under the above corporation. The quartzite used in the manufacture is obtained at Bellevue on the line of the Algoma Central railway, 20 miles north of Sault Ste. Marie. This material is probably Huronian quartzite from the Lorrain formation, and similar to that which occurs at Killarney.[1]

Sydney, N.S.—The Dominion Iron and Steel Company have been carrying on investigations on several quartzite deposits in Cape Breton with a view to utilizing them in the manufacture of silica brick if a suitable deposit can be found.

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[1] Summary Report Mines Branch, 1916, p. 115.

ROAD MATERIALS DIVISION.

K. A. Clark, *Chief of Division.*

Work by the Department of Mines on Road Materials was commenced, and has been continued up to the present time, by the Geological Survey Branch of the Department—under the supervision of Mr. L. Reinecke. Since 1913 surveys have been conducted during each field season. The testing of samples, however, was done outside the department until 1916, when the Mines Branch established a Road Materials laboratory. Since that time all samples of road materials collected by field parties of the department have been tested in this laboratory. By this arrangement the Road Materials Laboratory has assisted the Road Materials Division of the Geological Survey. The geological survey is now, however, retiring from the field, and all phases of the work will be transferred to the Mines Branch. In future field examination of road materials, as well as their laboratory testing and investigation, will be entirely in charge of the Road Materials Division now being organized in the Mines Branch.[1]

All samples received by the Road Materials Laboratory up-to-date have been tested, and the results are now available. The samples may be grouped as follows: (1) Samples of rock representing possible sources of supply of road material occurring along the Rideau canal, collected by L. Reinecke in 1916; (2) samples of gravel representing deposits of gravel occurring along the route of the proposed Toronto-Montreal highway from Port Hope to Napanee, Ont., collected by F. H. McCullough and by K. A. Clark, in 1916; (3) samples of rock representing deposits of road material occurring along the route of the proposed Hull-Montreal highway from Grenville to St. Eustache, Que., collected by H. Gauthier in 1916; (4) samples of rock and gravel representing available road material occurring in the counties of Soulanges and Vaudreuil, Que., and along the route of the Toronto-Montreal highway along the shore of the St. Lawrence river from the Quebec boundary to Prescott, Ont., collected by R. H. Picher in 1916 and 1917; (5) samples of rock representing the entire supply of stone for the city of Montreal, occurring in the city and on the Montreal and neighbouring islands, collected by H. Gauthier in 1917; and (6) samples of gravel representing the deposits of gravel occurring in the neighbourhood of Regina, Sask., collected by L. Reinecke in 1917.

During the summer of 1917 the writer supervised the collecting of a large number of samples to be used in obtaining data on the general problems of the sampling and testing of fieldstone and bed-rock. The testing of this material is complete, and the results have given considerable information on the problems in view.

TESTS OF SAMPLES OF BED-ROCK.

Samples were tested in accordance with the standard methods adopted by the U.S. Office of Public Roads.[2] Great care was exercised in collecting samples, in order to have them truly representative of the deposits. In the case of quarries around Montreal, and especially in the city, duplicate samples were taken at each place. The results given for quarries in the city of Montreal are in each case the average of tests on several samples separately collected. A table containing all the results of tests on bed-rock performed by the Road Materials Laboratory up-to-date appears at the end of this summary.

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[1] Since the writing of this Summary, the arrangement mentioned in the text has been effected.

[2] Methods for the Determination of the Physical Properties of Road-Building Rock, F. H. Jackson, U.S. Dept. of Agriculture, Bul. No. 347 (1916).

The tests for specific gravity and water absorption need no explanation. Absorption results are reported as pounds of water absorbed per cubic foot of rock.

The abrasion test, duplicates in a practical laboratory way, the abrasive action of traffic on the stone in a road bed. The test is made on fifty pieces of stone of cubical shape, and of about the same size, which in the aggregate weigh 5,000 grammes (11 pounds). This charge is revolved for 10,000 revolutions in an iron cylinder (20 by 34 cms.) set at an angle of 30° across the axis. The percentage by weight of the charge worn to powder by this operation is reported as the per cent of wear. The French coefficient of wear is calculated from the per cent of wear by dividing the later value into 40. Values for the French coefficient of wear vary over a wider range than values for the per cent of wear for the same change in the quality of rock, and also show increasing values for increasing resistance to wear.

The hardness test measures the resistance possessed by a rock to wear produced by dry grinding with an abrasive. Two cores 1-inch diameter, and cut from a solid block of the rock by a diamond drill, are used in the test. These cores are fastened in holders, and are made to rest on end under the pressure of a fixed total initial weight, on a revolving disc carrying a standard artificial quartz sand. The loss in weight of each core during 1,000 revolutions of the disc is noted. One-third of the average loss of the two cores subtracted from 20 is reported as the hardness of the rock.

The toughness test measures the resistance of a rock to fracture by impact. It is intended to duplicate the stresses undergone by rock fragments in a roadbed through the impact of horses' hoofs and of swiftly moving vehicles passing over slight obstructions in the roadway. The test is made on cylinders 1-inch diameter and 1-inch high, carefully prepared from diamond drill cores. The cylinders are subjected to blows from a 5-kilogram hammer, transmitted to the cylinder by a plunger with a spherical end resting on the cylinder. The height through which the hammer is dropped, is successively increased by 1 centimetre, until the point of failure of the cylinder is reached. The height of the blow in centimetres causing failure, is taken as the toughness of the cylinder. The average results, on at least three cylinders, is reported as the toughness of the rock.

A table compiled by the United States Office of Public Roads, from the results of their experience in correlating the results of laboratory tests with the behaviour of rock when used in road construction, is probably the best attempt that has been made to interpret the results of laboratory tests. This table, in slightly modified form, is given below. Reference to it will give a general idea of the type of road construction for which a rock, on which results of tests are available, is suited.

GENERAL LIMITING VALUES FOR BROKEN STONE. *(U.S. Office of Public Roads, Washington, D.C.).*

Type of Construction.	Traffic.[1]	Limiting Values.			
		% Wear.[2]	Fr. Coef.	Toughness.	Hardness.
Water-bound macadam, plain or with dust palliative treatment.	Light	8·0 to 5·0	5 to 8	5 to 9	10 to 17
	Moderate	5·0 to 2·5	9 to 15	10 to 18	14 or over
	Heavy	2·5 or less	16 or over	19 or over	17 or over
Macadam with bituminous carpet	Light to moderate	8·0 or less	5 or over	5 or over	(5)
Bituminous macadam with seal coat	Moderate to heavy	5·5 or less	7 or over	10 or over	
Bituminous concrete	Light to moderate	5·5 or less	7 or over	7 or over	(5)
	Moderate to heavy	4·0 or less	10 or over	13 or over	
Binder course for sheet asphalt or Topeka type	Any	5·5 or less	7 or over	6 or over	(5)
Portland cement concrete	Moderate to heavy		(4)	8 or over	16 or over
Stone paving block[3]	Any		(4)	9 or over	16 or over
Broken stone foundations / Cement concrete foundations	Any	13 or less	3 or less	3 or over	8 or over

1 Light traffic is assumed as less than 100 vehicles per day, moderate traffic between 100 and 250 vehicles, and heavy traffic over 250 vehicles per day.

2 Limiting values for the per cent of wear are not given in the table as published by the United States Office of Public Roads. The limits given in the above table are based on the limiting values for the French coefficient of wear, and are included for the convenience of those who prefer to think in terms of per cent of wear rather than in terms of French coefficient.

3 Crushing strength of 20,000 pounds, or greater per square inch, is frequently required.

4 Limits for French coefficient of wear (or per cent of wear), are not at present considered necessary for this type of construction.

5 Numerous tests have shown that limits for hardness are unnecessary if the material possesses the required French coefficient of wear (or per cent of wear) and toughness.

COMPARISON OF THE ROAD MATERIALS LABORATORIES WITH OTHER LABORATORIES.

The Department of Mines has formerly had samples tested in the laboratories of the Ontario Department of Public Highways, and also by Prof. A. H. Blanchard, Columbia University, New York, U.S.A. The results of these tests are published in Geological Survey Memoirs, Nos. 85 and 99. The limiting values given in the table just quoted are secured from the results of tests made in the laboratory of the U. S. Office of Public Roads, Washington. In order to compare the results of tests from these different laboratories and to use the table of the U. S. Office of Public Roads in interpreting them, it is important to know how closely tests made by all the laboratories concerned on the same material will agree. To secure this information, duplicate samples were collected and submitted for comparative tests between the laboratories of the U. S. Office of Public Roads, Columbia University; the Ontario Department of Highways; and the Mines Branch laboratory. The results are as follows:—

Results of Tests on Comparable Samples tested in the Laboratories of the U. S. Office of Public Roads; Road Materials Division, Mines Branch; and A. H. Blanchard, New York City.

Sample.	U.S. O.P.R.	Mines Branch.	Blanchard.
Diabase—			
Sp. gravity	2·95	2·99	3·01
Wt. per cub. ft.	184·00	187·00	187·00
Water absorbed	0·54	0·1	0·01
Per cent of wear	2·4	2·2	2·8
French coef. of wear	16·7	18·4	14·3
Hardness	18·0	18·3	18·9
Toughness	13	17	8
Cementing value	28	52	63
Limestone—			
Sp. gravity	2·66	2·54	2·74
Wt. per cub. ft.	166·00	159·00	171·00
Water absorbed	3·05	4·6	2·27
Per cent wear	4·8	3·8	4·4
French coef. of wear	8·3	10·5	9·0
Hardness	13·7	14·2	16·5
Toughness	4	6	9
Cementing value	18	18	25
Limestone—			
Sp. gravity	2·68	2·69	2·70
Wt. per cub. ft.	167·00	168·00	168·00
Water absorbed	0·56	0·3	0·28
Per cent of wear	4·9	4·1	4·7
French coef. of wear	8·2	9·7	8·5
Hardness	12·0	13·8	14·9
Toughness	4	6	4
Cementing value	27	28	75

Results of Tests on Comparable Samples tested by the Laboratories of the Ontario Department of Public Highways, and of the Road Materials Division, Mines Branch.

Sample.	Ontario Dept. of Highways.	Mines Branch.
Tinguaite—		
Sp. gravity	2·58	2·58
Wt. per cub. ft.	161·00	161·00
Water absorbed	0·7	0·2
Per cent wear	2·3	2·0
French coef.	17·4	20·0
Toughness	20	21
Cementing value	24	26
Sp. gravity	2·70	2·70
Wt. per cub. ft.	168·00	168·00
Water absorbed	1·7	0·3
Per cent of wear	4·7	4·0
French coef. of wear	8·5	10·0
Toughness	6	9
Cementing value	30	33

INVESTIGATIONAL WORK ON THE SAMPLING AND TESTING OF BED-ROCK.

The field work conducted around the city of Montreal during the season of 1917, and subsequent laboratory work, has been so planned and carried out that considerable information has been gathered relating to the general problem of the sampling and testing of bed-rock. The plan of this phase of the work can be summarized as follows:

I. To determine the probable variation in results of abrasion tests due to causes other than variation in the quality of the rock masses themselves, experiments were conducted to determine:—

(*a*) The probable variation in the results of tests due to laboratory manipulation.

(*b*) The probable variation in the results of tests on samples collected from the same material, and at the same place.

(*c*) The probable variation in the results of tests on samples collected from the rock in place in a quarry, and from the material obtained as a crushed product from the same quarry.

II. To secure information regarding the size of the mass of stone that can be fairly represented by one sample, experiments were conducted to determine:—

(*a*) The variation in quality of rock masses which appear in the outcrop or excavation to be of the same character.

(*b*) The magnitude of variations which are liable to appear between the results of tests on samples collected close together within the same sedimentary formation, but representing rock of apparently somewhat different character, due to a change in horizon.

(*c*) The variation in the results of tests on samples collected in the same sedimentary formation, but at points separated widely, both vertically and horizontally.

The following conclusions have been arrived at:—

1. The result of an abrasion test, expressed as per cent of wear, is liable to an error of 0·2 due to variation caused by laboratory procedure.

2. No additional error is introduced into the results of abrasion tests by the process of sampling as practised by the Road Materials Division.[1]

3. Results of abrasion tests on rock in place in a deposit represent within a probable difference of 0·4 the per cent of wear that will be obtained from crushed stone produced from the deposit.

4. In the case of deposits consisting of stone of a very uniform character and appearance, the results of abrasion tests on samples taken at one point in the deposit can be regarded as representing—within the probable error due to laboratory manipulation—the per cent of wear of the stone over quite a considerable area: at least a quarter of a square mile.

5. It is possible to assign an average value and fairly narrow limits of variation about this value for the per cent of wear and the toughness of material occurring in a limestone formation, even though stone of quite widely different character is included in the formation.[2] This has been proven by samples collected from all parts of formations up to 500 feet thick, and covering areas up to 50 square miles.

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[1] Great care is always exercised to make the samples for the abrasion test representative of the deposit being sampled. The height of the quarry face or deposit is first approximately determined and then equal numbers of pieces are taken from equal parts of the height. Pieces slightly larger than what is required for the abrasion test are secured. Fifty-five such pieces, constitute a sample.

[2] Average values and average deviations from these values for results of abrasion and toughness tests on samples collected in the limestone formation occurring in the Montreal district.

Formation.	Average % Wear and Average Deviation.	Average Toughness and Average Deviation.
Beekmantown	3·1±0·5	16±7
Black River	3·1±0·4	8±1·5
Chazy—		
(Montreal Island)	3·9±0·1	7±1
(Isle Jesus)	4·6±0·5	6±1·5
Trenton	4·1+0·6	7+1·5

6. These limits should define the reliability with which results of abrasion and toughness tests made on samples collected from a quarry in such limestone formations will continue to represent the material produced from the quarry as quarrying operations are extended from year to year.

SAMPLING AND TESTING OF FIELDSTONE.

Attention has been given during the past year to methods of sampling and testing fieldstone, and a satisfactory system has been devised.

Examination of areas in which fieldstone occur, shows that fieldstone deposits consist of mixtures of boulders of several characteristic rock types, depending on the locality. These types are easily recognized by their distinctive lithological character; and estimates of composition in terms of these types can quickly be made on large quantities of material as it occurs throughout an area. In collecting samples, and making tests to secure data for the interpretation of the information on composition obtained in the field, it has been found best to treat each type of material separately. Samples of each type entering into the composition of the deposits of fieldstone throughout an area, are sampled separately, and at several points in the area, if the area is large. From the results of the abrasion tests on these separate types, it is found that the per cent of wear of any combination of these types can be calculated. Conclusions can thus be drawn regarding the worth, as road material, of the combinations of types that have been found to make up the deposits in any particular locality examined.

Experiments have shown that the per cent of wear of a mixture of several rock types is a simple function of the per cent of wear of each rock type, and of the proportion expressed in per cent in which the types are present in the mixture. If the per cents of wear of the various types are expressd by W_1, W_2......W_n and the percentage of proportions in which they occur in the mixtures by C_1, C_2, ... C_n, the per cent of wear of the mixture W_n is given by the formula:—

$$W_m = \frac{\Sigma\, CW}{100}$$

One series of results are sufficient for illustration. (See page 129.)

SPECIAL SERIES OF TESTS OF BED-ROCK COLLECTED FROM THE QUARRIES IN THE CITY OF MONTREAL.

Special attention was paid to the sampling nd testing of rock from the quarries in the city of Montreal (including Outremont and Côte des Neige). In practically every case abrasion samples were collected in duplicate. This was done by securing in the quarry twice the number of pieces of rock necessary for one test and dividing this sample in two in the laboratory by quartering. In some cases, two single samples were collected in the quarry over the same part of the face and kept separate. When different types of rock occurred in a quarry, duplicate samples to represent such types were taken. When quarrying operations were being carried on in such a way as to keep separate the material from groups of beds of limestone or where decided variation in lithological character occurred in groups of beds in such a way that these beds could be quarried separately, samples were collected to represent such groups of beds. Samples were always secured from stock piles. Toughness blocks were secured to represent each type of rock occurring in a quarry and also to represent each important lithological phase of such types. The accompanying table gives the results of all tests made on these samples.

RESULTS OF TESTS ON SAMPLES COLLECTED FROM QUARRIES IN THE CITY OF MONTREAL.

Serial No.	Name and Location of Quarry.	Specific Gravity	Water Absorption	Per cent of Wear.	French Coef. of Wear.	Remarks about Abrasion Sample.	†Toughness.	Hardness.	Remarks about Toughness Sample.
156	Spring Grove Ave., rock cut, Outremont.	2·72	0·21	2·6	15·2	Very fine-grained, dark limestone. Duplicate samples.	5–6	14·9	Fine-grained, somewhat granular.
		2·73	0·18	2·7	14·8				
161	Corporation Quarry, Outremont.	2·68	0·54	2·3	17·4	Nepheline syenite. Duplicate samples.	20	17·4	Very fine-grained, uniform.
		2·67	0·79	2·5	16·0		14	18·6	Medium, uneven-grained.
							17	18·6	Medium-grained.
		3·10	0·37	2·3	17·4	Essexite, dark, non-uniform.	19	18·6	Very fine-grained.
		3·10	0·38	2·1	19·0	Duplicate samples.	6	17·8	Coarse-grained.
		2·77	0·05	3·4	11·8	Metamorphosed limestone.	5	13·8	Medium to coarse-grained.
		2·78	0·04	3·6	11·1	Duplicate samples.			
162	Rockland Ave. rock cut, Outremont.	2·94	0·14	2·1	19·0	Syenite, fine-grained with basic dike rock. Duplicate samples.	24	18·1	Fine-grained, dark syenite carrying pyrite.
		2·86	0·15	1·8	22·2				
		2·46	0·08	3·2	12·5	Metamorphosed limestone, dense to fine-grained.	17	18·1	Fine-grained to dense metamorphosed limestone.
		2·80	0·11	2·7	14·8	Duplicate samples.	15	18·1	Breccia. Syenite and metamorphosed limestone.
				3·8	10·5	Stock pile of crushed stone from cut.			
				3·0	13·3	Mixed composition. Duplicate samples.			
155	Stinson-Reeb Quarry, Outremont.	2·94	0·29	1·8	22·2	Nepheline syenite, fine-grained, containing pyrite. Duplicate samples.	30	18·4	Fine-grained, with finely divided pyrite.
		2·95	0·24	1·8	22·2				
163	Decelles St. rock cut, Côte de Neige.	3·24	0·16	2·5	16·0	Essexite, very coarse-grained. Duplicate samples.	10	18·3	Very coarse-grained.
		3·24	0·26	2·5	16·0				
168	O. Martineau & Sons, Carrière and Marquette Sts., Montreal.	2·70	0·07	3·9	10·3	Trenton limestone, coarse-grained with some shaly partings. Duplicate samples.	6–7	15·2	Fine to medium-grained, shaly partings.
		2·71	0·15	4·5	8·9				
		2·71	0·10	4·0	10·0	Limestone from south quarry, above building stone beds. Duplicate samples.	5–6	13·7	Rather coarse-grained, uniform.
		2·70	0·15	4·5	9·1				
		2·71	0·11	4·0	10·0	Limestone from building stone beds.	4–5	14·0	Rather coarse-grained, uniform.
		2·70	0·17	4·0	10·0	Limestone from crushed stone stock pile. Duplicate samples.			
		2·70	0·17	3·8	10·5				
165	Stinson-Reeb Quarry, Carrière and Chambord Sts., Montreal.	2·71	0·00	3·3	12·1	Trenton limestone, dense to fine-grained, from upper bench of quarry.	6	15·6	Dense.
		2·71	0·00	3·9	10·3	Limestone, dense to fine-grained, from lower bench of quarry.	8–9	16·9	Dense to fine-grained.
		2·70	0·00	3·5	11·4	Limestone from crushed stone stock pile. Duplicate samples.			
		2·71	0·06	3·4	11·8				
167	Jas. Gravel Quarry, Carrière and Chambord Sts., Montreal.	2·70	0·28	4·0	10·0	Trenton limestone, dense to medium-grained, from two lower benches of quarry.	8–9	16·0	Limestone, fine to medium-grained.
							9	17·4	Limestone, dense.
		2·73	0·97	4·0	10·0	Dike rock, fine-grained, granular, from bottom of quarry.	14	13·7	Dike rock, fine-grained.
		2·71	0·20	3·5	11·4	Limestone from crushed stone stock pile. Duplicate samples.			
		2·71	0·16	3·1	12·4				
164	Delorimer Quarry Co., Iberville and Masson Sts., Montreal.	2·71	0·14	3·0	13·3	Trenton limestone, dense to fine-grained. Occurs associated with stone of different texture but could be supplied separately.	7–10	16·5	Limestone, very fine-grained.
		2·71	0·20	3·0	13·3		7	15·7	Limestone, fine-grained to dense, shaly partings.

RESULTS OF TESTS ON SAMPLES COLLECTED FROM QUARRIES IN THE CITY OF MONTREAL—*Con.*

Serial No.	Name and Location of Quarry.	Specific Gravity	Water Absorption	Per cent of Wear.	French Coef. of Wear.	Remarks about Abrasion Sample.	†Toughness.	Hardness.	Remarks about Toughness Sample.
		2·71	0·14	3·7	10·8	Limestone, medium to coarse-grained. Duplicate samples collected separately.	6–7	15·4	Limestone, medium-grained, fossiliferous.
		2·71	0·20	3·9	10·3		4–6	14·7	Limestone, very coarse-grained.
		2·97	0·08	2·1	19·0	Dike rock from dike crossing the quarry. Duplicate samples.	30	18·9	Dike rock, very fine-grained.
		2·97	0·12	1·9	21·0				
		2·71	0·14	3·7	10·8	Limestone from crushed stone stock pile. Duplicate samples.			
		2·71	0·14	3·9	10·3				
154	Jas. Rogers Quarry, Iberville and Masson Sts., Montreal.	2·71	0·16	4·1	9·6	Trenton limestone, fine to coarse-grained, fossiliferous. Duplicate samples (separate).	7–7	16·2	Fine-grained, uniform.
		2·71	0·17	4·5	8·9		6–8	15·4	Fine to coarse-grained, fossiliferous.
							5–8	15·6	Fine to medium-grained, fossiliferous.
153	Jas. Rogers Quarry, Iberville and Masson Sts. (south of Masson St.) Montreal.	2·70	0·52	3·1	12·9	Trenton limestone, dense (banc noir). Duplicate samples.			
		2·74	0·28	2·5	16·0		11	17·2	Limestone, dense, dark.
				4·4	9·1	Limestone (banc noir), from different level. Duplicate samples.	8	......	Limestone, dense, dark.
				3·9	10·3		7–8	17·2	Limestone, dense, dark.
		2·70	0·17	3·4	11·8	Limestone from crushed stone stock pile. Duplicate samples.			
		2·71	0·14	3·5	11·4				
		2·45	1·75	2·8	14·3	Altered banc rouge from stock pile.			
		2·57	0·24	2·1	19·1	Tinguaite (banc rouge). Duplicate samples.	23	18·2	Tinguaite, medium-grained.
		2·59	0·18	1·9	21·1		23	19·0	Tinguaite, fine-grained.
		2·59	0·11	2·1	19·1	inguaite (banc rouge) from crushed stone stock pile. Duplicate samples.	11	18·6	Tinguaite, medium-grained, showing flow planes.
		2·58	0·19	2·2	18·2				
166	Morrison Quarry, south of Masson St., Montreal.	2·70	0·49	4·8	8·4	Trenton limestone (banc noir), dense, from lower level.	9–11	14·4	Limestone, very fine-grained.
							11–14	18·1	Limestone, dense.
		2·72	0·20	3·3	12·1	Limestone (banc noir), dense, from upper level.			
		2·59	0·17	2·0	20·0	Tinguaite (banc rouge), medium to coarse-grained.	22	18·8	Tinguaite, medium-grained.
		2·59	0·21	2·3	17·4	Tinguaite from stock pile of crushed stone........	18	17·7	Tinguaite, dense, flinty looking.
159	Ant. Davids Quarry, south of Masson St., Montreal.	2·58	0·10	2·0	20·0	Tinguaite (banc rouge)..........................	29	18·8	Tinguaite, fine-grained.
		2·59	0·12	1·9	21·0	Tinguaite from crushed stone stock pile.			
160	Fireproof Crushed Stone Co., south of Masson St., Montreal.	2·58	0·17	2·0	20·0	Tinguaite (banc rouge)..........................	21	18·6	Tinguaite, fine-grained.
157	Jos. Rhéaume Quarry, Bvd. Rosemont, Maisonneuve.	2·69	0·33	5·6	7·1	Trenton limestone, fine to coarse-grained, shaly partings, south end of lower bench.	7	14·8	Coarse-grained, fossiliferous.
							6	15·5	Fine-grained, shaly partings, fossiliferous.
		2·70	0·25	5·3	7·5	Limestone from centre of lower bench.............	4–6	14·8	Very coarse-grained, fossiliferous.
		2·70	0·31	6·6	6·1	Limestone from north end of lower bench..........	3–7	14·2	Very fine-grained with some shaly partings.
		2·70	0·33	4·6	8·7	Limestone from crushed stone stock pile. Duplicate samples.	9	14·0	Very fine-grained with some shaly partings.
		2·70	0·25	4·2	9·5				
158	Villeray Quarry, Rosaire and Boyer Sts., Montreal.	2·74	0·35	3·3	12·1	Chazy limestone, from upper beds. Duplicate samples collected separately.	9–10	15·4	Fine-grained, uniform.
		2·74	0·24	3·1	12·9		6–9	15·4	Fine-grained, uniform.
		2·73	0·19	3·2	12·5	Limestone from lower 5 ft. of quarry. Mostly coarse-grained. Duplicate samples.	6–7	13·8	Fine-grained, uniform.
		2·73	0·23	3·0	13·3		6–8	15·1	Fine to medium-grained.
		2·74	0·26	3·0	13·3	Limestone from crushed stone stock pile. Duplicate samples.			
		2·74	0·35	2·8	14·3				

*Values given in the table at the end of this report for the quarries in the City of Montreal are the average values of tests on samples collected from the rock in place in the quarries.
†Two values for toughness refer to tests made on cylinders cut parallel to and across the bedding planes.

TESTS ON FIELDSTONE FROM MONTREAL DISTRICT, QUE.

Type.	Per cent Wear.			
1. Igneous rock	4·3	3·5	Average	3·9
2. Trenton limestone	5·9	5·6	"	5·7
3. Fine-grained Potsdam sandstone	2·2	2·1	"	2·2
4. Beekmantown limestone	3·3	3·2	"	3·3

Mixtures of—	Per cent Wear. Actual.	Per cent Wear. Calculated.
50% type 1, and 50% type 2	4·7	4·8
" 1 " 3	3·0	3·1
" 1 " 4	3·6	3·6
" 2 " 3	2·8	4·0
" 2 " 4	4·6	4·4
" 3 " 4	2·8	2·8
25% type 1, 25% type 2, 25% type 3, and 25% type 4	3·7	3·8

The following are the actual results of tests upon fieldstone from the Montreal, Vaudreuil and Cornwall districts, collected during the season of 1917.

RESULTS OF TESTS ON FIELDSTONE TYPES.

Type.	Per cent Wear.	
Montreal District, Que.		
Igneous rock	3·2	(average of 6 tests).
Coarse Chazy limestone	5·0	" 8 "
Fine-grained Uniform Chazy limestone	3·3	" 2 "
Dense Black River limestone	3·7	" 2 "
Beekmantown limestone	3·3	" 2 "
Fine-grained Potsdam sandstone	2·2	" 2 "
Vaudreuil District, Que.		
Igneous	2·7	(average of 4 tests).
" (Devils Garden)	2·6	" 2 "
Beekmantown limestone	3·4	" 2 "
Fine-grained Potsdam sandstone	2·2	" 3 "
Cornwall District, Ont.		
Igneous	2·7	(average of 2 tests).
Black River limestone	3·6	" 2 "
Fine-grained Potsdam sandstone	2·3	" 2 "

TESTING OF GRAVELS.

Tests have also been made on twenty-one samples of gravel collected to represent the deposits of this material occurring along the Toronto-Montreal Highway from Port Hope, Ont., to Napanee, Ont. These tests consist of complete granulometric analyses; determination of the voids; and abrasion tests on the pebbles contained in the material. On account of the bulky nature of such results, they will not be given here. Seventeen gravel samples from the neighbourhood of Regina, Sask., were also tested by Mr. L. Reinecke. This work included, besides the abovementioned tests, determinations of the compressive and tensile strength of cement mortars prepared from the sand constituent of the gravels.

TESTING OF BALL MILL PEBBLES.

Five samples of pebbles from Gabarus Bay, Cape Breton, N.S., of possible value as ball mill pebbles, were submitted to the Road Materials Laboratory for test by Dr. A. O. Hayes, Geological Survey of Canada. These pebbles were tested in the Deval Abrasion Machine, and compared for wearing quality with commercial flint pebbles. Very favourable results were obtained. Details of the experiments will appear in the Summary Report of the Geological Survey.

RESULTS OF TESTS OF BED-ROCK.

Locality.	Rock Species.	Age of formation.	Physical Properties.					
			Per cent Wear.	French Coef. of Wear.	Tough-ness.	Hard-ness.	Spec. Grav.	Absorp. in lb. per cu. ft.
	Rideau Lakes, Ontario.							
Seely's Bay	Diabase,	Pre-Cambrian	2·3	17·4	9	18·7	3·05	0·1
West shore Opinicon Lake, $\frac{3}{4}$ mile southwest of Chaffey's Locks.	Meta-andesite,	"	2·3	17·4	21	17·7	2·84	0·2
	Trenton to Napanee, Ont.							
Bleeker's quarry, north Belleville	Limestone with shale,	Trenton	5·0	8·0	8	15·2	2·72	0·2
Point Anne quarry, Point Anne	Limestone,	"	4·0	10·0	6	14·0	2·70	0·4
South bank of Salmon river, 4 miles northwest of Shannonville	"	"	6·9	5·8	4	13·2	2·72	0·5
P. Bergin's quarry, Napanee	"	"	4·9	8·2	7	15·5	2·71	0·1
	Two Mountains and southeast Argenteuil, Que.							
Two miles east of Rawcliffe, Chatham township	Syenite porphyry,	Pre-Cambrian	2·0	20·0	38	19·2	2·70	0·8
Hearst's quarry, northwest of Lachute	Granite gneiss,	"	2·2	18·2	13	18·5	2·75	0·2
Laurentian Granite Co., Brownsburg	Coarse-gr. granite,	"	4·0	10·0	9	18·8	2·64	0·5
Argenteuil Granite Co., Brownsburg	" "	"	3·8	10·5	9	18·8	2·64	0·6
Premier Granite and Sand Co., St. Canute	Granite gneiss,	"	2·3	17·4	12	18·6	....	....
Southeast of LaTrappe, Oka	Anorthosite,	"	2·6	15·4	13	18·6	2·66	0·5
East of St. Benoit	"	"	6·0	6·7	9	....	2·75	0·4
East of St. Benoit	Diabase,	?	2·7	14·6	23	18·6	3·02	0·9
Husereaus farm, Ste. Germaine Rd., north of Oka	Alnoite,	Palæozoic	3·4	11·8	12	18·2	3·26	0·8
One-half mile north of Ste. Monique	"	"	2·9	13·8	16	17·6	3·15	0·1
Mt. St Alexis, north of Oka	Diabase,	?	2·6	15·4	18	18·2	2·91	0·3
Smith's quarry, 1 mile southwest of St. Philippe	Limestone,	Chazy	4·4	9·1	6	15·7	2·73	0·3
Binettes quarry, St. Augustin	Dolomite,	Beekmantown	3·8	10·6	17	15·9	2·80	0·3
Thompson's quarry, north of Belle Rivière	Dolomite and magn. limestone.	"	5·3	7·5	20	15·8	2·76	0·5
Gratton's quarry $2\frac{1}{2}$ miles east of St. Hermas sta.	"	"	2·8	14·3	17	16·7	2·82	0·1
Col. Smith's quarry, St. Jerusalem road, Lachute	Dolomite	"	3·9	10·3	11	14·5	2·86	0·5
McQuat's quarry, Lachute	"	"	3·0	13·3	17	17·1	2·79	0·5
Near Ottawa river, Cushing	"	"	3·5	11·4	13	16·7	2·94	2·0
Fraser's quarry, Lachute	"	"	3·2	12·5	16	15·9	2·84	0·7
Cote des Anges, Ste. Scholastique	Calcareous sandstone,	"	5·9	6·8	....	....	....	....

	Soulanges and Vaudreuil Counties, Que.							
West of Isle Cadieux Station	Alnoite	Palæozoic	4·4	9·2	13	17·4	3·23	0·9
One and one-half miles southeast of St. Lazare	Medium-gr. pink granite.	Pre-Cambrian	3·6	11·0	13	18·8	2·71	0·5
Dempsey's quarry, Coteau Jct.	Dolomite,	Beekmantown	3·5	11·4	17	16·3	2·84	1·0
Bedard's quarry, Ste. Justine	"	"	2·8	14·8	15	16·9	2·80	0·5
At foot of mountain, 1 mile west of Rigaud	Granite,	Pre-Cambrian	2·6	15·4	13	18·7	2·63	1·0
Ste. George range, Rigaud mountain	Syenite porphyry,	"	2·3	17·5	18	18·9	2·73	0·5
Bank of Rigaud river, west of Rigaud	Dolomite,	Beekmantown	3·4	11·8	15	17·0	2·76	1·2
	Along St. Lawrence River, from Quebec boundary to Prescott, Ont.							
Clark's quarry, north of Cornwall	Limestone,	Black River	3·3	12·1	8	16·0	2·70	0·2
Friend's quarry, north of Cornwall	"	"	3·5	11·4	6	16·6	2·70	0·3
Empey's quarry, north of Mille Roches	"	"	3·2	12·5	5	16·4	2·69	0·4
Manson s quarry, north of Mille Roches	"	"	3·5	11·4	....	....	2·70	0·2
Adam's quarry, west of Cardinal	Magn. limestone,	Beekmantown	2·9	13·8	5	15·6	2·79	0·7
Warren's quarry northeast of Cardinal	"	"	3·2	12·5	11	16·3	2·79	1·0
Fisher's quarry west of Iroquois	"	"	2·7	14·8	9	16·5	2·78	1·0
	MONTREAL AND NEIGHBOURING ISLANDS.							
	Isle Perrot.							
Quinland & Robertson quarry, Isle Perrot	Sandstone	Potsdam	3·7	10·8	16	19·4	2·59	0·9
Quarry of Municipality of Isle Perrot	"	"	2·4	16·7	10	19·2	2·59	0·7
	Isle Jesus.							
Nap Clermont's quarry, Bord à Plouffe	Limestone,	Chazy	4·2	9·5	5	13·9	2·70	0·4
G. Clermont's quarry, Laval des Rapides	"	"	4·2	9·5	9	15·6	2·68	0·5
A. Gauthier's quarry, St. Martin	"	"	3·3	12·1	8	14·4	2·71	0·8
Elie Bigras' quarry, St. Martin	"	"	4·5	8·9	6	13·5	2·70	0·4
Daurien Bigras' quarry, St. Martin	"	"	4·3	9·3	5	13·1	2·69	0·3
St. Laurent quarry (main quarry) Cap St. Martin	"	"	5·6	7·1	6	13·5	2·67	0·7
St. Laurent quarry (south of rd.) Cap St. Martin	"	"	4·9	8·2	4	11·9	2·68	0·4
Isaie Desormeaux quarry, Cap St. Martin	"	"	5·8	6·9	4	9·6	2·67	0·7
J. Desormeaux quarry, Cap St. Martin	"	"	5·1	7·8	5	13·3	2·69	0·6
A. Paquette's quarry Cap St. Martin	"	"	4·2	9·5	7	14·3	2·69	0·5
Village Bélanger	"	"	5·0	8·0	6	14·3	2·69	0·5
G. Lecavalier's quarry, Côte St. Elzéar	"	"	5·2	7·7	7	14·4	2·70	0·5
Penitentiary quarry, St. Vincent de Paul	"	"	4·2	9·5	6	14·3	2·71	0·2
H. Archambault's quarry, St. Vincent de Paul	"	"	4·3	9·3	6	14·2	2·70	0·2
Ed. Jolicoeur's quarry, St. Vincent de Paul	"	Trenton	5·7	7·0	....	....	2·70	0·2
	"	"	4·1	9·8	6	14·2	2·70	0·2
Gédéon Legris' quarry, St. Vincent de Paul	"	"	3·6	11·1	5	14·9	2·70	0·2
Gédéon Legris' farm, St. Vincent de Paul	Dike Rock,	Palæozoic	2·2	18·2	29	18·5	2·87	0·4
North Shore Rivière de Prairie, St. Vincent de Paul	"	"	2·4	16·7	14	17·2	2·89	0·8

RESUTS OF TESTS OF BED-ROCK—*Continued.*

Locality.	Rock species.	Age of formation.	Physical Properties. Per cent Wear.	French Coef. of Wear.	Tough-ness.	Hard-ness.	Spec. Grav.	Absorp. in lb. per cu. ft.
Ulric Sauriol's quarry, St. Vincent de Paul	Limestone,	Trenton	3·9	10·3	7	15·3	2·70	0·1
Felix Labelle quarry, St. François de Salles	"	"	4·4	9·1	6	14·6	2·70	0·4
J. O. Labelle & Co., quarry, St. François de Salles	"	"	3·5	11·4	7	14·5	2·72	0·8
Montreal Concrete Works quarry, St. François de Salles	"	"	3·6	11·1	7	14·7	2·72	0·5
Kennedy Construction Co. quarry, St. François de Salles	"	"	3·9	10·3	8	14·8	2·71	0·4
Alphonse Couvette quarry, Ste. Dorothée	"	Black River	3·6	11·1	16	17·4	2·73	0·4
Camille Laurin's quarry, Ste. Dorothée	Dike Rock,	Palæozoic	2·0	20·0	18	18·0	2·83	0·8
T. Gauthier's quarry, Ste. Dorothée	Magn. limestone,	Beekmantown	3·3	12·1	11	15·8	2·76	1·3
	Isle Bizard.							
J. D. Théoret's quarry, Isle Bizard	Limestone,	Chazy	3·9	10·3	6	14·4	2·69	0·4
	Montreal Island.							
A. H. Maher's quarry, Ste. Anne de Bellevue	Magn. limestone,	Beekmantown	3·1	12·9	14	16·8	2·80	0·4
H. Morgan's quarry, Senneville	" "	"	4·2	9·5	8	16·0	2·70	1·4
Hon. J. L. Perron's quarry, Beaconsfield	" "	"	2·6	15·4	26	17·8	2·74	1·1
	" "	"	2·4	16·7	28	16·6	2·73	1·4
Charlebois & Chetagne's quarry, Pointe Claire	Limestone,	Black River	2·3	17·4	7	16·3	2·70	0·2
G.T.R. quarry, Pointe Claire	"	"	3·2	12·5	....	....	2·70	0·5
Gédéon Meloche's quarry, Pointe Claire	"	"	3·1	12·9	6	15·4	2·69	0·3
	"	"	2·8	14·3	7	17·2	2·71	0·2
Quarry of Messrs. Lavigne & La Framboise, Ste. Geneviève	"	Chazy	3·9	10·3	6	13·7	2·68	0·5
Adénai St. Denis' quarry, Ste. Geneviève	"	"	3·7	10·8	5	14·9	2·69	0·8
O. Laniel's quarry, Ste. Geneviève	"	"	3·8	10·5	7	16·1	2·70	0·8
E. Lecavalier's quarry, Cartierville	"	"	3·9	10·3	7	14·9	2·70	0·2
H. Cousineau's quarry, Cartierville	"	"	3·8	10·5	7	14·9	2·72	0·5
Quarry of Messrs. Carrière & Deguire, St. Laurent	"	"	3·9	10·3	7	15·0	2·73	0·8
J. Rhéaume's quarry, Bordeaux	"	"	4·1	9·8	6	13·9	2·70	0·7
O. Martineau & Fils quarry, Côte St. Michel	"	"	3·9	10·3	6	13·9	2·70	0·2
J. Dejardin's quarry, Rivière de Prairie	"	Trenton	5·6	7·1	6	13·6	2·69	0·5
Quinlan & Robertson quarry, Côte St. Michel	"	"	3·5	11·4	6	14·7	2·70	0·1
	Dike Rock,	Palæozoic	2·4	16·7	18	17·3	2·78	0·6
Quarry of Municipality of Montreal East, Montreal	Limestone,	Black River	3·7	10·8	9	14·7	2·69	0·5
	Dike Rock,	Palæozoic	2·4	16·7	28	18·0	2·94	1·6

	Outremont, Côte des Neiges, City of Montreal.							
Spring Grove Ave. cut, Outremont	Limestone,	Trenton	2·7	14·8	6	14·9	2·72	0·2
Corporation quarry, Outremont	Nepheline syenite,	Palæozoic	2·4	16·7	17	18·2	2·68	0·7
	Syenite & Essexite,	"	2·2	18·2	12	18·2	3·10	0·4
	Metamorphosed Limestone,	"	3·5	11·4	5	13·8	2·77	0·1
Rockland Ave. cut, Outremont	Dike Rock,	"	2·0	20·0	24	18·1	2·90	0·2
	Metamorphosed Limestone and Breccias,	"	3·0	13·3	17	18·1	2·80	0·1
Stinson Reebe quarry, Outremont	Nepheline syenite,	"	1·8	22·2	30	18·4	2·94	0·3
Decelles St., Côte des Neiges	Essexite,	"	2·5	16·0	10	18·3	3·24	0·2
O. Martineau & Sons, Carrière & Marquette Sts., Montreal.	Limestone,	Trenton	4·2	9·5	5	14·3	2·71	0·1
Stinson, Reebe Co. quarry, Carrière & Chambord Sts., Montreal.	"	"	3·6	11·1	8	16·2	2·71	0·0
Jos. Gravel Quarry, Carrière & Chambord Sts., Montreal.	"	"	4·0	10·0	9	16·7	2·70	0·3
	Dike Rock,	Palæozoic	4·0	10·0	14	15·8	2·73	1·0
Delorimer quarry Co., Iberville & Masson Sts., Montreal.	{Limestone,	Trenton	3·4	11·8	5	15·6	2·71	0·2
Jas. Roger's quarry, Iberville and Masson St., Montreal.	{Dike Rock,	Palæozoic	2·0	20·0	30	18·9	2·97	0·1
	Limestone,	Trenton	4·3	9·3	7	15·7	2·71	0·2
Jos. Rhéaume's quarry, Bld. Rosemount, Maisonneuve	"	"	5·8	6·9	6	14·8	2·70	0·3
Jas. Roger's quarry, Iberville & Masson Sts. (south of Masson St.), Montreal.	"	"	3·7	10·8	9	17·2	2·70	0·3
	{Tinguaite (banc rouge)	Palæozoic	2·0	20·0	19	18·6	2·58	0·2
	{Metamorphosed Limestone.	"	2·8	14·3	.....	.....	.....	.....
Morrison's quarry, south of Masson St., Montreal	Limestone,	Trenton	4·0	10·0	11	16·0	2·70	0·4
	Tinguaite,	Palæozoic	2·0	20·0	20	18·5	2·59	0·2
Ant. David's quarry, south of Masson St., Montreal	"	"	2·0	20·0	29	18·8	2·58	0·1
Fireproof Crushed Stone quarry, south of Masson St., Montreal.	"	"	2·0	20·0	21	18·6	2·58	0·2
Villeray quarry, Rosaire & Boyer St., Montreal	Limestone,	Chazy	3·1	12·9	8	15·0	2·74	0·3

DIVISION OF CHEMISTRY.

F. G. Wait, *Chief of Division.*

The chemical laboratory has been kept constantly engaged during the year, and the usual wide variety of samples has been attended to. The whole time of one assistant, and part of that of another has been devoted to the examination and analysis of war materials. This, it has been felt, is our paramount duty at the present moment, and, as a result, some departmental work has been held back for a longer period than was customary.

The detail work done during the year may be conveniently tabulated as follows:—

1. Assays for Gold, Silver, and Platinum: Three hundred and four samples, distributed as follows, from:—

Alberta	3	samples.
British Columbia	20	"
New Brunswick	2	"
Nova Scotia	14	"
Ontario	70	"
Quebec	9	"
	and 186	"

of which no information as to locality was available.

2. Alloys: Eight samples. These comprised brass, 3; bronze, 3; typemetal, 1; and nickel, crude, 1.

3. Antimony Ores: Twenty-two samples. All from undesignated localities in British Columbia.

4. Building Stones: Fifty-two samples from the undermentioned localities in British Columbia; all collected by Dr. W. A. Parks:—

(*a*) Ten Cretaceous sandstones, examined to ascertain the nature and quantity of the cementing material in each, from: Denman island, Gabriola island, Hornby island, 2 samples; Mayne island, buff; Newcastle island, Salt Spring island, Saturna island, 2 samples, buff, and blue; Jack Point, Nanaimo.

(*b*) Twelve granites—in each of which the sulphur content was determined—from: Agassiz, Granite island, Hardy island, Kamloops lake, Nelson, Nelson west of Nelson island, Okanagan lake, 2 samples—red and blue; Rossland (monzonite), Smith island, Tyee.

(*c*) Two volcanic rocks—sulphur content only determined—from: Dease lake, near Kamloops, B.C.; Haddington island.

(*d*) Eight marbles—complete analysis—from: Grant Brook, 2 samples, red and white; Kaslo, 1 sample, white; Marble Head, 2 samples, grey and white; Nootka sound, 2 samples, grey and white; Texada island, 1 sample, white.

5. Copper Ores: Forty-five samples, distributed as follows:—

i. *Nova Scotia*: Thirteen samples from:—

a. Sterling zinc-copper deposit, Cape Breton co.

b. Dunbrack argentiferous galena prospect in Musquodoboit area, Halifax co.

ii. *Ontario:* Ten samples, from:—

a. Algoma, mining location W.R. 92, timber berth No. 138, near Whiskey lake, township 138.

b. Hastings, 5 samples from lot 14, con. IX of Hungerford tp.

c. Kenora, 3 samples from unsurveyed territory, near English station, C.P.R.

d. Sudbury, lot 1, con. VII, of Lorne township.

iii. *British Columbia:* One sample from Rithet's farm, near Victoria.
iv. *Northwest Territories:* Four samples from Bathurst inlet.
v. *Undesignated localities:* Seventeen samples.

6. Ferrosilicon: Several samples have been submitted to complete analysis.

7. Glass Sand: One sample of crushed white sandstone from lot 6, con. I, Nepean township, Ottawa front, Carleton co., Ontario.

8. Graphite: Four samples from the Globe Graphite Co's. property, situated on lot 20, con. VI, of North Elmsley, Lanark co., Ontario.

9. Iron Ores: Twelve samples, as follows, from:—
i. *Ontario:* Four samples of hematite, with some magnetite, from the Fort William district—precise locality not stated.
ii. *Quebec:* Two samples of limonite, bog iron ore—one from Bolton township, Brome county, and one from Weir, Argenteuil county.
iii. *British Columbia:* One sample of limonite, from a point half a mile north of Alta Lake station, on the P.G.E. Ry.

10. Identifications:
Under this heading may be grouped 178 samples of various kinds, which were submitted for determination of species, or other fitting description. None are of special interest except to the person to whom they belonged, hence are not scheduled for special mention. In all cases the results have been communicated to the sender.

11. Lead Ores: Nineteen samples, as follows:—
i. *Nova Scotia*: Thirteen samples.
a. Cape Breton county, Sterling zinc-copper deposits, 10.
b. Halifax county, Dunbrack argentiferous galena prospect, Musquodoboit area, 3 samples.
ii. *Ontario*: One sample.
Hastings county, lot 26, con. (?) of Madoc township and
iii. *Unstated localities*: Five samples.

12. Limestones, Dolomites, and Magnesites. 105 samples.
i. *Quebec*: Eighty samples:
a. Argenteuil county, 74 specimens of dolomites and calcareous magnesites from exposures on lot 15, on ranges IX, X, and XI, of Grenville township.
b. Eskimo island—Gulf of St. Lawrence—3 samples.
c. Charles island—Hudson straits—3 samples.
ii. *Ontario*: One sample:
Carleton county, lot 22, con. XII of Fitzroy township, from the C.N. Ry. cutting.
iii. *Alberta*: Two samples—both from the immediate vicinity of Fort McMurray—one from what is locally known as Paul Miller's ledge on the river, and one from an exposure between the H. B. Co.'s store and Horse creek.
iv. *British Columbia*: Eight samples:
Localities shown under heading "Building Stones."
v. *Unspecified localities:* Fourteen samples.

13. Manganese Ores: Five samples:
i. *Nova Scotia:*
Lunenburg county, a supposedly manganiferous biotite from the granite at New Ross.
ii. *British Columbia*: Three specimens from the vicinity of Poplar.
iii. One specimen, the locality of occurrence of which was not stated.

14. Molybdenum Ores and Concentrates.
36 samples—
i. Thirty samples of concentrates were analysed for the Ore Concentration plant.

ii. Two samples of ore from a deposit at Mount St. Patrick, Renfrew county, Ontario.

iii. Four from undesignated localities have been submitted to partial analysis during the year.

15. Nickel Ores and Metal.

Eight samples—

These were from the following localities:—

i. *Ontario:* Carleton county, lot (?), con. (?), Fitzroy township.
Kenora district, vicinity of English station, C.P.R. (2 samples).
Kenora district, Stanton property, near Vermilion bay.
Thunder Bay district, vicinity of Jellicoe station.

ii. *British Columbia:* Rithet's farm, near Victoria.

iii. One specimen of shot nickel (metallic).

iv. One specimen, locality not stated.

16. Rocks and Minerals: Thirty-two samples, as follows:—

i. *Prince Edward Island:* Supposed glass sand from near Charlottetown.

ii. *Quebec:* Colerainite, crystalline, from the old Standard mine, Black Lake, Megantic co.
Colerainite, amorphous, from the old Standard mine, Black Lake, Megantic co.
Massive serpentine, from the Carr mine, Coleraine, Megantic co.
Stichtite, white, from the Lambly mine, Coleraine, Megantic co.
Clastic rocks—undesignated—four samples from the Grenville series, from the headwaters of the Opawika river, in northern Quebec.

iii. *Ontario:* Sandstone, from ridge of Grenville quartzite, situated on lots 15 and 16, con. I of Elizabethtown, Leeds co., Ontario.
Moulding sand from Leeds co. (vicinity of Brockville).
Celestite, partial analysis, from lot 7, con. X, of Bagot, Renfrew co.

iv. *Manitoba:* Eight samples of clays and soil, as follows:—
Subsoil of the Red River valley, vicinity of Winnipeg, 2 samples.
Niobrara shale, middle beds, N. ½ sec. 35, 2, 6, W. of 1st meridian, Deadhorse valley, west of Morden, No. 2 of section.
Niobrara shale, base of upper beds, NE. ¼ sec. 34, 2, 6, W. of 1st., No. 3 of section.
'Chalk,' buff weathering beds of upper Niobrara, Deadhorse valley, N. ½ sec. 23, 2, 6, W. of 1st, No. 6 of section.
White bands in the black and white beds at the base of the Pierre, Pembina valley, sec. 22, 1, 8, No. 7 of section.
Black band in the black and white beds at the base of the Pierre, Pembina valley, sec. 22, 1, 8, W. of 1st.
Millwood shale, N. ½ sec. 29, 1, 5. Face of escarpment in southern part of field.

v. *Saskatchewan:* Six clays from:—
Eastend, secs. 5 and 6, township 7, range 21, west of 3rd. meridian (4 samples).
Eastend, sec. 25, township 6, range 21, west of 3rd. meridian.
Willows, sec. 12, township 8, range 29, west of 3rd. meridian (2 samples).

Five siliceous rocks from vicinity of Amisk lake, and 1 glass sand—a 'war material'—from an undefined locality.

17. Sandstones for Structural Purposes: (See under Building Stones).
18. Steel: Thirty-one samples.
19. Sulphur-bearing Ores: Four samples—all from Ontario:—
    One from the Stanton property, Vermilion bay, Kenora district.
    Two from unspecified localities in Fitzroy township, Carleton co., and
    One from Nickel lake, Rainy River district.
20. Waters and Brines: Sixteen samples, from:—
    i. *Nova Scotia:* Three samples:—
    Stake Road: from a drill hole 70 feet in depth.
    Inverness mine, Inverness, 2 samples of acid mine waters.
    ii. *Saskatchewan,* 12 samples: one from each of the following localities, all collected by Mr. J. Stansfield:—
    SW. 17, 16, 20, W. of 2nd.
    NW. 26, 16, 21, W. of 2nd.
    SE. 32, 15, 21, W. of 2nd.
    SE. 12, 24, 30, W. of 2nd.
    NE. 33, 16, 9, W. of 2nd., flowing well, 8 m. SE. of Regina.
    SW. 30, 13, 18, W. of 2nd., owner, Zimmer.
    NE. 31, 14, 17, W. of 2nd., owner, Reich.
    NE. 11, 7, 13, W. of 2nd., owner, Glen Topham.
    NW. 14, 4, 11, W. of 2nd., owner, F. F. Beyer.
    Rouleau, town supply, from two wells pumped simultaneously.
    Holbrite, town supply.
    Sedley, town supply, from a 54-foot well at south end of rink.
    iii. *Alberta,* one (brine) from No. 1 well of the Peace River Oil Co., on Peace river.

REPORT OF THE DIVISION OF MINERAL RESOURCES AND STATISTICS.

JOHN MCLEISH, *Chief of Division.*

During 1917, this Division has, as usual, been occupied with the duties involved in the collection of statistics and records respecting the mining and metallurgical industries of Canada, and the preparation of Annual Reports on mineral production, etc.

During the past two years, the amount of work has been considerably increased, through the collection of monthly statistics of production of pig-iron, steel and coal; this monthly collection having been extended during 1917, to cover asbestos and pyrites.

COLLECTION OF STATISTICS, AND PREPARATION OF REPORTS, ETC.

Statistics of production are collected by correspondence from some 3,500 smelter, mine and quarry operators, throughout the Dominion. These inquiries are supplemented by the collection of records of ore and mineral shipments from railway companies; ore receipts by smelting companies both in Canada and in the United States; and other data having a direct bearing on mineral production, or on mineral consumption.

The period covered by the statistical record is the calendar year; and for many years it has been found possible to complete a preliminary report on the mineral production of Canada which has been sent to press during the last week in February, and distributed during the first week in March.

The collection of monthly production records for coal, iron, steel and certain other metals, has permitted much earlier estimates to be completed, so that on the first of January, 1917, there had already been given to the public a close estimate of the production of iron, steel, coal, nickel and other metals, during 1916; while before the end of December, 1917, similar estimates for 1917 had already been completed and made public.

In the completion of the final reports on mineral production during the calendar year 1916, Mr. A. Buisson has compiled the statistics with respect to metals and metallic ores, and has prepared the text of the chapters on gold, copper, lead, nickel, silver, zinc and other miscellaneous metals. He has also compiled the "List of Metal Mines and Smelters."

Mr. Casey has, as usual, compiled all the statistics of the production of non-metalliferous products and structural materials, as well as the record of imports of mineral products, and has prepared for publication the various "List of Mine and Quarry Operators"—with the exception of the "Metal Mines List".

The following reports and lists were completed during the year, and sent to press on the dates indicated:—

Reports—

- Preliminary Report on the Mineral Production of Canada, during the calendar year 1916—February 28, 1917.
- The Production of Iron and Steel in Canada, during the calendar year 1916—June 16, 1917.
- The Production of Coal and Coke in Canada, during the calendar year 1916—July 20, 1917.
- The Production of Cement, Lime, Clay Products, and other Structural Materials, during the calendar year 1916—August 18, 1917.
- The Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and other Metals in Canada, during the calendar year 1916—August 28, 1917.
- Annual Report on the Mineral Production in Canada, during the calendar year 1916—October 27, 1917.

Lists of Mine Operators—

- List of Coal Mine Operators in Canada, August 22, 1917.
- List of Mines in Canada (other than Metal Mines, Coal Mines, Stone Quarries, Clay Plants, etc.), September 5 ,1917.
- List of Cement Mills and of Sand-Lime Brick Plants, September 14, 1917.
- List of Manufacturers of Clay Products, September 14, 1917.
- List of Manufacturers of Lime in Canada, September 14, 1917.
- List of Stone Quarry Operators, September 20, 1917.
- List of Operators of Sand and Gravel Pits, September 27, 1917.

Special Bulletins, or Press Notices—

- Iron and Steel in Canada (Revised Statistics), 1916.
- Iron and Steel in Canada, 1917, January to March.
- Iron and Steel in Canada, 1917, January to June.
- Iron and Steel in Canada, 1917, January to September.
- Coal and Coke in Canada, 1916 (Revised Statistics).
- Coal and Coke in Canada, 1917, January to March.
- Coal and Coke in Canada ,1917, January to June.
- Monthly Production of Coal by Provinces, 1917, January to October.
- Asbestos in Canada, 1916, and first six months of 1917.

In addition to the preparation of reports, lists of operators, and special bulletins, much time is devoted to the preparation of Memoranda respecting mineral production and consumption, mineral resources, etc., for the information of correspondents, and for other Government departments.

During 1917, special inquiries were undertaken with regard to the production of pyrites ore and of sulphuric acid, for the information of the Munition Resources Commission. We were able, in September, to furnish a complete record of pyrites shipments for the first eight months of the year, together with a close estimate of the total shipments for the calendar year, showing the sulphur contents, and the quantities exported to United States. In respect to sulphuric acid, no record of Canadian production had hitherto been available. A complete record was obtained, covering production during each of the five years to the end of 1916, and during the first six months of 1917.

COLLECTION OF MONTHLY STATISTICS.

The collection of monthly statistics of production of iron and steel, and coal, which was begun in 1916, and to which reference was made in my summary report of last year, was continued in greater detail during 1917. At first, the collection was undertaken quarterly, but in the case of coal—at the request of the Fuel Controller—this was extended to an actual monthly collection. The tabulated results of these monthly records have been furnished to the public in the special bulletin and press notices already listed.

CO-OPERATION WITH CENSUS AND STATISTICS OFFICE IN COLLECTION OF MINERAL PRODUCTION STATISTICS FOR 1917.

The Census and Statistics Office of the Department of Trade and Commerce having undertaken to collect a comprehensive annual census of production and industry, approached this department with a view to securing our co-operation in the collection of the mineral production records which would otherwise have been duplicated by that office.

As a result of the method of co-operation agreed upon, the Census Office will accept the records of mineral production as collected by the Department of Mines; the census respecting capital, labour, cost of materials used, power used, etc., being collected directly by the Census Office. To attain this end, the following notice has been sent out with each of our schedules for the collection of 1917 statistics of production:—

NOTICE.

An Industrial Census, including mining and allied interests, is being taken by the Census and Statistics Office as for 1917. By arrangement with the Department of Mines, the record of MINING PRODUCTION collected by the latter as for 1917 will be accepted as a part of this

Census, the forms employed in this connection having been approved by Order in Council, and the chief of the Division of Mineral Resources and Statistics having been appointed for this purpose an agent of the Census, under Clauses 9 and 6 of the Census and Statistics Act respectively. The object of this arrangement is to avoid duplication of inquiries and consequent trouble to operators.

ROBERT H. COATS,
Dominion Statistician,
and Controller of Census.
Department of Trade and Commerce.

JOHN McLEISH,
Chief of the Division of Mineral
Resources and Statistics.
Department of Mines.

MINERAL RESOURCES RECORDS.

In my first Summary Report on taking charge of this Division in 1908, I described the "Card Index to Mineral Occurrences"; the "Mineral Occurrence Record Fyle"; and the "Clipping System for mining information", that had already been established as part of the organization of the Mineral Statistics and Mines Division of the Geological Survey.

This indexing and fyling has been continued in the Division of Mineral Resources and Statistics only in so far as our very limited staff would permit. In order that the Division may carry out more completely the function "to collect and preserve all available records of mines and mining works in Canada", it will be necessary to provide a special staff for the purpose, and bring the Division into the closest possible co-operation with the economic field work of the whole Department and to provide that all field officers shall turn in to this Mineral Resources Record Office, copies of all data collected respecting mineral resources.

The incomplete fyles already available in this Division, have been of the utmost value to the members of the Mines Branch staff in planning their field work.

DRAUGHTING DIVISION.

H. E. Baine, *Chief Draughtsman.*

Twenty-eight maps were compiled during the year, and delivered to the Government Printing Bureau ; also 184 mechanical drawings, sketch maps, and charts were executed, to accompany the various reports of the Branch.

The following is a list of maps prepared and published during the calendar year 1917:—

434. Coal fields of New Brunswick and Nova Scotia.
438. Magnetometric map, Western Steel Iron Claim, Sechart, Vancouver Island, B.C.
439. Magnetometric map, Baldwin mine, Hull tp., Que.
441. Magnetometric map, Wilbur mine, Lavant tp., Lanark county, Ont.
442. Magnetometric map, Iron Crown claim, Nimpkish river, Vancouver Island, B.C.
443. Magnetometric map, Bristol mine, Pontiac county, Que.
444. Magnetometric map, Northeast Arm Iron range, Nipissing district, Ont.

Fig. 1, Map, Southwestern British Columbia, showing location of chief quarries and outcrops, "Building Stones of Canada."

Fig. 2, Map, Eastern British Columbia, showing location of chief quarries and outcrops, "Building Stones of Canada."

Fig. 3, Map, Prince Rupert district, showing location of chief quarries and outcrops, "Building Stones of Canada."

459. Moose Creek Peat Bog, Prescott, Russell and Stormont counties, Ontario.
460. Westmeath Peat Bog, Renfrew county, Ont.
461. Meath Peat Bog, Renfrew county, Ont.
462. Farnham Peat Bog, Missisquoi and Iberville counties, Que.
463. Canrobert Peat Bog, Rouville county, Que.
464. Napierville Peat Bog, Napierville county, Que.
468. Geological map, Southern Saskatchewan, to accompany report on "Clay Resources of Southern Saskatchewan."
469. Cypress Hill sheet, to accompany report on "Clay Resources of Southern Saskatchewan."

Not published—

- Magnetometric map, Huron Mountain mine, Nipissing district, Ont.
- Magnetometric map, lot 7a, range VI, Leeds tp., Que.
- Magnetometric map, Matawin Iron Range, claims 491R, 492R, 494R and 478R, Thunder Bay district, Ont.
- Magnetometric map, Maloney mine, Marmora tp., Hastings county, Ont.
- Map, Bog Iron Ore Deposits, Vancouver Island, B.C.
- Geological map, McPherson mine, Barachois, Cape Breton county, N.S.
- Geological map, Ingram sheet, Cape Breton county, N.S.
- Geological map, Arisaig sheet, Antigonish county, N.S.
- Geological map, showing distribution of iron ore occurrences in Cape Breton.

REPORT COVERING THE OPERATIONS OF THE DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C., DURING THE YEAR ENDING DECEMBER 31, 1917.

I

REPORT OF THE MANAGER, G. MIDDLETON.

Following is a report covering the operations of the Dominion of Canada Assay Office, Vancouver, B.C., for the calendar year ending December 31, 1917, accompanied by statements showing Assayers' and Melters' supplies on hand.

The business of the office had outgrown the capacity of our bullion balances, and a new balance with a capacity of 5,000 ounces in each pan, sensibility 0·005 ounces; 5-foot bronze beam of special design, with steel bearings, was installed last April, together with a new set of brass truncated troy weights, 500 ounces down to ·001 ounce and 10 additional 500-ounce brass truncated troy weights, which are a pronounced acquisition to our equipment.

The electric protection of our vault was thoroughly overhauled last October, and the lining and wiring of the inside of vault renewed.

When the market where the local manufacturing jewellers and manufacturers of dental supplies formerly purchased gold was closed to them last fall, this office was requested to sell gold for manufacturing purposes. On November 21 authority was received to comply with the request, provided a declaration is furnished in each instance that the gold is to be used only for manufacturing purposes in Canada. Sales are now being made regularly, and the arrangement is much appreciated by the manufacturers. Disbursements and receipts for the purchase and sale of the gold are embodied in the statement under the heading "' Disbursements and Receipts, etc.," in this report.

There were 1,583 deposits of gold bullion received, melted, assayed and purchased, and before disposing of same the bars weighing under 500 ounces each were assembled and melted into large bars, which were also assayed. A total of 1,800 meltings and 1,800 assays was required in connexion with the purchase and disposal of the bullion. All assays were run in quadruplicate. Two hundred and fifty ounces of quartation silver were manufactured, and punched into discs ranging in weight from 25 to 750 mg.; 15,000 cupels of different sizes were also manufactured; and 445 pounds of slag treated, and the values contained in same recovered.

The aggregate weight of the gold bullion deposits before melting was 191,626·04 troy ounces, and after melting 187,884·48 troy ounces; showing a loss in melting of 1·9525 per cent. The loss in weight by assaying was 30·44 troy ounces, making the weight of bullion after melting and assaying 187,854·04 troy ounces; the average fineness of same being ·835½ gold and ·127 silver.

The net value of the gold and silver contained in deposits was $3,257,220.71, and was received from the following sources:—

Source.	Number of Deposits.	Weight (Troy ozs.)		Net Value.
		Before Melting.	After Melting.	
British Columbia	943	112,083·82	109,065·17	$1,994,844·50
Yukon Territory	637	79,532·35	78,809·93	1,262,207·27
Alaska	3	9·87	9·38	168·94
	1,583	191,626·04	187,884·48	$3,257,220·71

CREDITS AND DISBURSEMENTS FOR THE PURCHASE OF GOLD BULLION.

Unexpended balance "Letters of Credit," January 1, 1917	$ 374,648 59	
Credits established	3,200,000 00	
Balance written off at close of fiscal year, March 31, 1917	....	$ 161,749 79
Disbursements	....	3,257,220 71
Unexpended balance "Letters of Credit," December 31, 1917	....	155,678 09
	$3,574,648 59	$3,574,648 59

DISBURSEMENTS AND RECEIPTS FOR THE PURCHASE AND SALE OF GOLD BULLION AND DIFFERENCE BETWEEN AMOUNTS PAID AND RECEIVED FOR SAME.

Value of bullion on hand, January 1, 1917	$ 3,082 87	
Disbursements for the purchase of bullion during year ending December 31, 1917	3,257,220 71	
Proceeds from sale of bullion	....	$3,209,299 85
Value of bullion on hand, December 31, 1917	....	53,903 70
Difference	22,899 97	
	$3,263,203 55	$3,263,203 55

CONTINGENT ACCOUNT.

Unexpended balance, January 1, 1917	$ 0 76	
Funds provided per official cheques Nos. 2614, 2940, 3251, 7, 223, 571, 818, 1099, 1320, 1549, 1787 and 2019	6,025 00	
Amount remitted Receiver General per Draft No. 265 at close of fiscal year, March 31, 1917		$ 84 38
Expenditure		5,610 53
Unexpended balance, December 31, 1917		330 85
	$6,025 76	$6,025 76

CONTINGENT EXPENDITURE.

Fuel (gas)	$ 713 93
Power	252 44
Express charges on bullion	2,593 59
Re-lining and re-wiring vault for electric protection	150 00
Electric vault protection service	300 00
Postage	60 00
Telephones	79 80
Duty, express, freight, etc., on supplies and new equipment	236 52
Assayers' and melter's supplies (purchased locally)	932 60
Sundries	291 65
	$5,610 53

PROCEEDS FROM SALE OF RESIDUES.

Residue sold to the United States Assay Office, Seattle, Wash., U.S.A. (Bar No. A. 11)	$822 75
43 empty acid bottles sold to the B.C. Assay & Chemical Supply Co., Ltd., Vancouver, B.C.	5 16
	$827 91

RESIDUES ON HAND, DECEMBER 31, 1917.

Value of residue recovered from slags, sweepings, old furnaces, old crucibles, etc.	$781 71
27 empty acid bottles.	

MISCELLANEOUS RECEIPTS.

Draft No. 260 in favour of Deputy Minister of Mines (a payment for one special assay)	$ 2 00
Draft No. 264 in favour of Deputy Minister of Mines (refund by Dominion Express Co., express charges collected in error)	2 60
Draft No. 296 in favour of Deputy Minister of Mines (a payment for melting and assaying 99·59 ounces bullion)	2 50
Draft No. 305 in favour of Deputy Minister of Mines (a payment for treating 43·57 ounces unretorted amalgam)	2 50
Draft No. 340 in favour of Deputy Minister of Mines (a payment for treating 49·67 ounces scrap)	2 00
Draft No. 360 in favour of Deputy Minister of Mines (a payment for gold assays on nine wedding rings)	18 00
Draft No. 361 in favour of Deputy Minister of Mines (a payment for one special assay)	2 00
Draft No. 380 in favour of Deputy Minister of Mines (a payment for treating 21 lb. slag)	4 00
	$35 60

The following shows the business done by the Assay Office during the past 5 years:—

Calendar Year.	Number of Deposits.	Weight (Troy ozs.)	Net Value.
1913	783	111,479·95	$1,448,625 37
1914	1,112	166,148·83	2,029,251 31
1915	1,901	183,924·49	2,736,302 31
1916	1,779	180,292·83	2,828,239 65
1917	1,583	191,626·04	3,257,220 71

LIST OF REPORTS, BULLETINS, ETC., PUBLISHED DURING THE YEAR 1917.

MARC SAUVALLE, *Chief of Publishing and Translating Division.*

S. GROVES, *Editor Department of Mines.*

217. Iron Ore Occurrences in Canada, Vol. I: Descriptions of Principal Iron Ore Mines. Report on—compiled by E. Lindeman, M.E., and L. L. Bolton, M.A., B.Sc. Introductory by A. H. A. Robinson, B.A.Sc. Published November 29, 1917.

337. Catalogue of Mines Branch Publications (Eighth Edition). Published June 7, 1917.

388. Building and Ornamental Stones of Canada, Vol. IV: Manitoba, Saskatchewan, and Alberta. Report on—by W. A. Parks, Ph.D. Published April 19, 1917.

411. Cobalt Alloys with Non-Corrosive Properties. Report on—by H. T. Kalmus, B.Sc., Ph.D. Published February 12, 1917.

420. Production of Coal and Coke, during the calendar year 1915. Bulletin on—by John McLeish, B.A. Published February 12, 1917.

421. Mines Branch Summary Report for 1915. Published January 18, 1917.

423. Production of Cement, Lime, Clay Products, Stone, and other Structural Materials in Canada, during the calendar year 1915. Bulletin on—by John McLeish, B.A. Published March 7, 1917.

424. General Summary of the Mineral Production of Canada during the calendar year 1915. Bulletin on—by John McLeish, B.A. Published January 4, 1917.

425. Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and other Metals in Canada, during the calendar year 1915. Bulletin on—by John McLeish, B.A. Published March 7, 1917.

426. Mineral Production of Canada during the calendar year 1915. Annual Report on—by John McLeish, B.A. Published May 18, 1917.

430. Coal Fields and the Coal Industry of Eastern Canada. Report on—by F. W. Gray. Published May 30, 1917.

432. The Thin Coals of Eastern Canada. Report on—by J. F. K. Brown. Published August 28, 1917.

435. The Mineral Springs of Canada. Part I: The Radioactivity of Some Canadian Mineral Springs. Report on—by John Satterly, M.A., D.Sc., and R. T. Elworthy, B.Sc. Published December 24, 1917.

440. Mines Branch Standard Specifications, in two parts: Part I—Specifications; Part II—Models. Prepared by S. Groves. Published March 15, 1917.

447. The Value of Peat Fuel for the Generation of Steam. Report on—by John Blizard, B.Sc., Published June 23, 1917.

449. Preliminary Report on the Mineral Production of Canada during the calendar year 1916. By John McLeish, B.A. Published March 6, 1917.

458. Production of Iron and Steel in Canada during the calendar year 1916. Bulletin on—by John McLeish, B.A. Published October 26, 1917.

465. Production of Coal and Coke in Canada during the calendar year 1916. Bulletin on—by John McLeish, B.A. Published December 3, 1917.

466. A Test of Some Canadian Sandstones to determine their Suitability for Use as Pulpstones. Bulletin on—by L. H. Cole, B.Sc. Published October 29, 1917.

470. The Production of Cement, Lime, Clay Products, Stone, and other Structural Materials in Canada, during the calendar year 1916. Bulletin on—by John McLeish, B.A. Published December 24, 1917.

List of Mine Operators—

List of Coal Mine Operators in Canada.

List of Mines in Canada (other than Metal Mines, Coal Mines, Stone Quarries, Clay Plants, etc.).

List of Cement Mills and of Sand-Lime Brick Plants.

List of Manufacturers of Clay Products.

List of Manufacturers of Lime.

List of Stone Quarry Operators.

List of Operators of Sand and Gravel Pits.

FRENCH TRANSLATIONS.

214. French translation: The Copper Smelting Industry of Canada. Report on—by A. W. G. Wilson, Ph. D. Published June 18, 1917.

255. French translation: Calabogie Iron-bearing District. Report on—by E. Lindeman, M.E. Published April 18, 1917.

267. French translation: Investigation of the Peat Bogs and the Peat Industry of Canada, 1911-1912. Bulletin No. 9—by A. Anrep. Published April 11, 1917.

292. French translation: The Petroleum and Natural Gas Resources of Canada. Report on—by F. G. Clapp, A.M., and others: Vol. I: Technology and Exploitation. Published April 20, 1917.

300. French translation: Peat, Lignite, and Coal: their Value as Fuels for the Production of Gas and Power in the By-product Recovery Producer. Report on—by B. F. Haanel, B.Sc. Published October 11, 1917.

304. French translation: Moose Mountain Iron-bearing District. Report on—by E. Lindeman, M.E. Published March 19, 1917.

306. French translation: The Non-metallic Minerals used in the Canadian Manufacturing Industries. Report on—by Howells Fréchette, M.Sc. Published July 12, 1917.

308. French translation: An Investigation of the Coals of Canada, Vol. VI. Report on—by J. B. Porter, and others. Published November 30, 1917.

324. French translation: The Products and By-products of Coal. Report on—by Edgar Stansfield, M.Sc., and F. E. Carter, B.Sc., Dr. Ing. Published February 23, 1917.

326. French translation: The Salt Industry of Canada. Report on—by L. H. Cole, B.Sc., Published May 1, 1917.

335. French translation: Electro-plating with Cobalt and its Alloys. Report on—by H. T. Kalmus, B.Sc., Ph.D. Published June 14, 1917.

345. French translation: Electro-thermic Smelting of Iron Ores in Sweden. Report on—by A. Stansfield, D.Sc., F.R.S.C. Published June 7, 1917.

352. French translation: Investigation of the Peat Bogs and the Peat Industry of Canada, 1913-1914. Bulletin No. 11—by A. Anrep. Published May 30, 1917.

386. French translation: Investigation of a Reported Discovery of Phosphate at Banff, Alberta. Bulletin No. 12—by H. S. deSchmid, M.E., 1915. Published June 28, 1917.

414. French translation: Magnetic Properties of Cobalt and Fe_2Co. Report on—by H. T. Kalmus, B.Sc., Ph.D. Published June 28, 1917.

422. French translation: Summary Report of the Mines Branch for 1915. Published April 24, 1917.

427. French translation: The Mineral Production of Canada during the calendar year 1915. Annual Report on—by John McLeish, B.A. Published December 18, 1917.

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